STUDIES ON THE FEEDING AND SOCIAL BEHAVIOUR OF DOMESTIC HORSES

Volume I

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Ph. D
University of Edinburgh
1979

Acknowledgements

The work in this thesis was supported by a scholarship from the Faculty of Veterinary Medicine and I would like to extend my sincere thanks to this body for their support. In addition I should like to express gratitude to Professor G. S. Ferguson for the provision of experimental facilities.

My supervisor, Dr. D. G. M. Wood-Gush, has given help and guidance throughout the study and to him I express my sincere thanks.

It is a pleasure to acknowledge Mr R. G. Carson for his expert help in designing and building the grazing recorder.

I would also like to take this opportunity to thank all other members of the Department of Animal Health, Veterinary Field Station who have given help and encouragement throughout this study. In particular thanks are due to Mr M. V. Thrusfield for his literary advice, Mr A. McDonald for his technical assistance and to the stable staff for co-operating with my constant demands.

Thanks are also due to Mr P. Teague, Poultry Research Centre, for his valuable help with statistics and to the technical staff of the Poultry Research Centre for their technical help.

In addition I am extremely grateful to Mrs M. Forder for typing this thesis, to Mr R. Munro for the photographic work and to

Mrs H. London for obtaining the references.

To these people and to others who have contributed to this work I extend my sincere thanks.

This thesis has been composed by me, and it is a record of my own work.

Katherine Francis-Smith

Abstract

In this study some aspects of the behaviour of domestic horses which had previously received little attention were investigated.

Documentation on the behaviour of horses falls into two broad categories; there are studies on populations of free-ranging horses and studies on domestic horses. The latter usually concentrate on one particular behaviour pattern whereas the former cover all aspects of the horses' behaviour. In the literature on domestic horses there was a lack of information on grazing behaviour and on the behaviour of mares and foals after the perinatal period and as a result it was decided to concentrate on these two aspects. In addition since most recordings are made by visual observation and experimental numbers are usually small it was felt that if a suitable grazing recorder could be designed it would improve the scope of studies on grazing behaviour.

Mares and foals were observed from the first day after parturition until the foals were weaned. It was found that although the mares are very attentive towards their foals during the first few days after birth by the second week they showed little interest in their foals. The foals were responsible for maintaining contact with their dams and they also initiated all nursing activity. They nursed frequently but nursing time decreased as the foals grew older. All the foals ate their dams' faeces during the first few weeks of life and it was thought that by doing this the foals

obtained bacteria necessary for the digestion of fibre. Weaning was a stressful event from which the foals appeared to recover quickly.

Horses were observed at grass and while stalled. The feeding of supplementary hay to horses at grass was found to affect their eliminative behaviour patterns and caused them to excrete randomly in the field. In contrast, during the summer months, unsupplemented horses consistently excreted on the areas of ungrazed grass (roughs) and grazed areas of short grass (lawns) in preference to the roughs.

Studies during periods of 24 hr indicated that horses spend most of the day eating and that continuous periods of grazing behaviour lasting 6 hr are not unusual. Horses in a group grazed and rested at the same time as one another and resting behaviour was more likely to occur during the hours of darkness than during daylight.

An electronic grazing recorder was designed and used successfully. This was the first serious attempt to invent a grazing recorder for horses and it is felt that it will have an important effect on future studies.

The results obtained and their implications for the management of horses and for future research are discussed.

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1 INTRODUCTION

1 Introduction

The motorization of transport and farm machinery after the First World War caused a decline in Britain's horse population from 2.2 million animals in 1920 to 845,000 in 1951 (Olsson and Ruudevere, 1955). However, with an increased interest in both leisure and competitive riding in Britain the horse population has risen again. Figures are not available for the number of horses in Britain today but in 1979 there are two million riders, excluding the racing, hunting and polo playing fraternity (British Horse Society, 1979) and this gives some indication of Britain's present day horse population.

Since the horse is a 'luxury' animal it has not yet been subjected to the intensive husbandry systems applied to other farm animals. However, with a regular annual loss of agricultural land in Britain (Champion, 1974) there is an increasing necessity to obtain maximum output from the land. Horses are expensive animals to keep. When they are pastured their hooves damage the turf and they leave large areas of pasture ungrazed (Archer, 1977). In addition, present methods of stabling horses demand many hours of human labour for their daily management and they require specialised buildings. When new management systems are designed the primary consideration must be the comfort of the animal. Problems such as weight loss, cannibalism and increased disease have arisen amongst other domestic ungulates when they were subjected to management systems that had been devised more for the benefit of human attendants than the animals themselves (Kiley-Worthington, 1977). To design a management

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system that takes into account the comfort of the animal then this must be known. Meanwhile, as already stated, the horse has been spared intensive husbandry, and this is reflected in the lack of documentation on the daily maintenance behaviour patterns of domestic horses. In recent years there has been an increased interest in the behaviour of horses in relation to their management (Archer, 1971, 1972a and b, 1973, 1977 and 1978; Houpt, 1977, 1978; Odberg, 1975; Odberg and Francis-Smith, 1976 and 1977) and it is believed that this subject will become more important in future years. Therefore, it was considered necessary to investigate certain aspects of the behaviour of horses to collect some basic information on maintenance behaviour of domestic horses.

2 REVIEW OF THE LITERATURE

2 Review of the literature

2:1 Proem

Studies on the behaviour of horses can be divided into two types; population studies on free-ranging horse herds and studies on domestic horses. The latter usually concentrate on a particular aspect of behaviour such as sexual, gustatory or maternal behaviour while the former cover all aspects of behaviour. Other ungulate species have also been studied in domestic and free-ranging environments and, where relevant, these species will be compared with the equid species.

2:1:1 Free-ranging horses

The few populations of horses alive today that are free from man's interference are found in refuges where they are protected by law. Two such populations have been studied with regard to their behaviour and ecology. There are the horses living in the Pryor Mountain Wild Horse Range, U.S.A. This range covers 33,600 acres in Wyoming and Montana, and varies in height from 3,650 ft to 8,000 ft above sea level. Barriers, both fences and natural barriers such as the Bighorn Canyon, enclose the range preventing the horses from straying onto Forest Service land or private land (Feist, 1971). Secondly there are the wild horses of Sable Island. This island is a sand bar 25 miles long and less than a mile wild, located 100 miles east of Nova Scotia. It is swept by strong winds and covered in fog for more than 100 days a year (Welsh, 1975). The horses in both of these places are left to live, breed and die without any interference from man. This is not true of many other free-ranging horse herds. In America horses

are culled to reduce competition with branded livestock and to supply pet food canneries and rodeos (McNight, 1959). In Britain, native ponies are rounded up each year and yearlings are caught and sold (Tyler, 1972). Similarly, in Japan, young males are removed from a population of feral horses each year (Imanishi, 1950). These treatments affect the sex ratios and age structure of the populations.

The behaviour of these horse groups can be compared with the behaviour of the three zebra species which is well documented (Klingel, 1968a; 1969a and b) and of wild ass herds (Klingel, 1971).

2:1:2 Domestic horses

Studies on domestic horses have covered many aspects of behaviour. Some work concentrates on areas of obvious economic importance, such as early post-natal behaviour (Rossdale, 1969 and 1970), sexual behaviour of mares (Witherspoon, 1971) and stallions (Wierzbowski, 1958 and 1959) and the milk consumption of nursing foals (Bouwman, 1978). There are general observations of horses in domestic conditions (Collery, 1974; Schoen, Banks and Curtis, 1976). Many studies concentrate on a particular aspect of behaviour such as sleep (Ruckebusch, Barbey and Guillemot, 1970; Steinhart, 1937), grazing and eliminative behaviour (Odberg, 1975; Taylor, 1954), social behaviour (Montgomery, 1957; Williams, 1974), pawing (Odberg, 1973), facial expressions (Trumler, 1959; Zeeb, 1959) and even foetal behaviour (Fraser, 1977).

2:2 The social organisation of Equidae

The different species of Equidae are all similar in body size and shape; they are all grazing, gregarious animals and will all interbreed. However there is a striking difference between the species in their social organisation. Grevy's zebra (E. grevyi), the wild ass (E. africanus), the asiatic wild ass (E. hemionus) and the feral donkey (E. africanus f. asinus) are territorial (Klingel, 1969b,1971 and 1975a; Moelhman, 1974). However the horse (E. przewalski f. caballus), the mountain zebra (E. zebra) and the plains zebra (E. quagga) are non-territorial (Feist, 1971; Klingel, 1968 and 1969a). Both types of behaviour and their functions are described in a review on this subject (Klingel, 1974a). It is not known whether the wild horse (E. przewalski) is territorial or non-territorial since it has not existed outside captivity since the 1940s (Mohr, 1971).

2:2:1 Non-territorial organisation

The non-territorial equid species live in stable family groups consisting of one stallion with between one and several mares and their offspring. In addition there are bachelor groups composed of adolescent and mature males. These groups have large home ranges which they share with conspecifics. The family stallions stay with their mares throughout the year and mating can occur at any time (Feist and McCullough, 1975; Klingel, 1968a and 1969a; Welsh, 1975).

2:2:2 Territorial organisation

Males and females of the territorial species are found either alone

or in groups composed of either males, females and their young or of both sexes (Klingel, 1974a). These groups are unstable and the composition may change within hours. Territories are set up by some solitary stallions and all conspecifics, including other stallions, are able to enter and leave the territories. Inside a territory the territorial stallion is dominant and only he will court and mate oestrous females. In an area without territories several stallions may fight continually over an oestrous mare with the result that none of them mates her. Territoriality therefore assists uninterrupted mating (Klingel, 1975a).

Grevy's zebra and wild asses live in areas where there is irregular rainfall and the territories are established in the wet season grazing areas. During the dry season all the animals, except for the territorial stallions, emigrate. Since the migratory stallions do not mate with the mares mating is restricted to the rainy season when they return to the territorial males (Klingel, 1974a and b).

Territoriality may be a more primitive form of social organisation than non-territoriality which allows the horse, the plains zebra and the mountain zebra more freedom of movement and greater reproductive potential than Grevy's zebra or the wild ass (Klingel, 1972a). Some behaviour patterns such as dominance and leadership, social bonds between individuals and marking behaviour differ between the territorial and the non-territorial equids but most other behaviour patterns are similar.

2:2:3 Dominance

The term dominance is used widely in the literature despite the fact that there is no standard definition of dominance. It is generally thought that dominance means the priority of access to a desired object (Chance, 1956). Furthermore different workers have recorded different behaviour patterns from which to assess dominance. In a review on dominance (Kiley-Worthington, 1977) the many weaknesses of such studies are pointed out and the variation in the concept of dominance and the methods used to measure it are criticised.

Most studies on free-ranging equids include data on dominance and leadership. Usually the frequency of threats and submissions has been used to assess dominance in these cases (Tyler, 1972; Klingel, 1974a). Stable dominance hierarchies occur in the family groups of the non-territorial african Equidae (Klingel, 1967, 1968a) and feral horses (Berger, 1977; Ebhardt, 1954; Welsh, 1973). In these species the family stallion is the dominant animal in a group. In contrast the territorial equids have no dominance hierarchies. A territorial stallion is dominant to all other conspecifics when the stallion is in his own territory but all other animals appear to be of equal rank (Klingel, 1969b and 1971). It is interesting that the feral horses of the Pryor Mountain Wild Horse Herd differ from other non-territorial equids in this respect. Stallions are the dominant animals in family groups but there is no hierarchy amongst the mares. In one situation a mare may be dominant to another mare but in a similar situation at another time the dominance might be reversed (Feist

and McCullough, 1976).

Dominance hierarchies have also been studied in domestic horses. In some cases the frequency of naturally occurring aggressive and submissive actions have been used to assess dominance (Collery, 1974; Montgomery, 1957). In other studies a limited food source has been provided to stimulate a faster rate of aggressive interactions (Grizmek,1949; Houpt, 1978). Most results show that domestic horse groups have linear dominance hierarchies with occasional triangular relationships (Collery, 1974; Houpt et al., 1978; Montgomery, 1957) and that the provision of a limited food source does not affect dominance relationships (Clutton-Brock, Greenwood and Powell, 1976; Tyler, 1972). Furthermore these hierarchies remain stable over several years (Houpt, 1979).

Facial expressions of threat and submission in both wild and domestic equids have been well documented (Antonius, 1939; Schafer, 1975; Trumler, 1959; Zeeb, 1958 and 1959). Bites and threats to bite occur more often than kicks or threats to kick (Clutton-Brock et al., 1976; Montgomery, 1957) and possibly for this reason a kick has been considered to be a more aggressive action than a bite (Houpt et al., 1978; Tyler, 1972). There is no evidence in the literature to suggest that this is the case and as yet there is no objective method of measuring aggression.

Attempts have been made to correlate a horse's rank with its age, weight, sex and aggressiveness. Some studies suggest that dominance is related to age and weight (Clutton-Brock et al., 1976;

Grzimek, 1949; Montgomery, 1957; Tyler, 1972) or that males are dominant to females (Montgomery, 1957). Other studies report no correlation between the rank of a horse and its age, weight or sex except that juveniles (animals less than three years old) are always subordinate to adults (Houpt et al., 1978; Houpt, 1979). In addition it has been stated that the offspring of dominant mares are likely to become dominant in their own groups (Houpt, 1978; Tyler, 1972). Dominance has been correlated with aggression but as stated previously the method used to measure aggression was unreliable. Apparently dominance is unrelated to the choice of partners for mutual grooming or the proximity of conspecifics (Clutton-Brock et al., 1976). It is suggested that the function of dominance is to reduce aggression between conspecifics (Hafez, Schein and Ewbank, 1969; Scott, 1956).

2:2:4 Leadership

Leadership is a phenomenon distinct from dominance (Gyr, 1946). A leader is the animal that determines the speed and direction of movement of a group of animals and leadership is usually assessed by studying the order in which animals in a herd move (Squires and Daws, 1975). In free-ranging non-territorial equids the leader of a family group is usually the most dominant mare and the rest of the group follow in order of decreasing dominance, with the stallion usually a short distance behind the group (Klingel, 1974a; Welsh, 1973). In the absence of a stallion the situation remains the same (Tyler, 1972) indicating that the group is led by the mare and not driven by the stallion. In the territorial equids there is no leader and any animal may initiate

movement in the herd (Klingel, 1972a). Amongst the feral horses of the Pryor Mountain Wild Horse Herd, in which there are no hierarchies amongst the mares, it is usually the family stallion that leads a group (Feist and McCullough, 1976). There is no reference to leadership amongst domestic horses in the literature although cattle, pigs and sheep have been studied in this respect (Leyhausen and Heinemann, 1975; Meese and Ewbank, 1973; Syme and Syme, 1975).

2:2:5 Social bonds

A striking difference between the territorial and non-territorial Equidae is in the formation of affiliative bonds between two or more conspecifics. Amongst the territorial species the only bonds are those between a mother and her foal. There are no permanent bonds between any two adults (Klingel, 1975a). In contrast, the non-territorial family groups are cohesive units that exist without any force from the stallion (Ebhardt, 1954; Klingel, 1969c). When a family stallion dies the group remains intact and a new stallion takes the whole group over (Klingel, 1967). This is illustrated further by the New Forest ponies in which due to the scarcity of stallions, many cohesive family groups consist only of adult females and their offspring (Tyler, 1972). Some feral horse groups are less stable than those of the plains zebra and adult females are sometimes abducted from family groups by other stallions (Feist, 1971; Welsh, 1973). Again, the horses of the Pryor Mountain Wild Horse Herd differ from both territorial and non-territorial equids, for amongst these horses the primary force for the cohesion of family groups

is the force of the stallions (Feist, 1971).

2:2:6 Marking behaviour

Marking behaviour has been recorded in all the equine species (Dobroruka, 1961; Ebhardt, 1954; Klingel, 1967, 1968a, 1969b and 1972a). This behaviour pattern consists of an animal defaecating or urinating onto the faeces or urine of a conspecific and sometimes stallions defaecate onto their own faeces (Klingel, 1974a). Marking behaviour is shown mainly by stallions and foals but only in the territorial species does it have a function. Territorial stallions frequently defaecate onto their own faeces producing large dung piles. These dung piles are located along the boundary of the stallion's territory and act as a visual signal to conspecifics (Klingel, 1974b). Some non-territorial horse stallions form dung piles. In these cases the piles are used by more than one stallion and are found throughout the horses' home range. Defaecation onto these piles occurs either when the horses pass by them in their daily movements or as part of a ritualised display that occurs when two stallions meet (Feist and McCullough, 1976; Welsh, 1973). Plains zebra and mountain zebra however are not reported to use dung piles (Klingel, 1972a). In captivity adult male wild horses (E. przewalski) form dung piles but the significance of this is uncertain as the social organisation of this animal in the wild is unknown (Dobroruka, 1961). From the point of view of evolution marking behaviour in non-territorial equids is postulated to be a vestigial behaviour pattern inherited from territorial ancestors (Klingel, 1972a).

2:3 The feeding and eliminative behaviour of horses

2:3:1 Eliminative behaviour

Under domestic conditions the grazing and eliminative behaviour of horses have been shown to be closely associated with each other (Odberg, 1975). Small fields that are only grazed by horses quickly develop areas of short, grazed grass (lawns) and areas of taller grass (roughs) that are not grazed. There are two reasons for this. Horses kept in small fields show a tendency to group their excrement into certain areas of the field (Odberg and Francis-Smith, 1976). Secondly horses do not graze near horse faeces (Odberg and Francis-Smith, 1977). This aversion to grazing near faeces has been described as an anthelmintic behaviour (Taylor, 1954) since it reduces the chances of horses ingesting their own parasites. If this is the case it is an ineffective control since ponies can develop serious parasitic infections within 20 days of being pastured (Round, 1971). Thus fields grazed only by horses develop a characteristic appearance. The roughs support abundant herbage with a high potassium content and the lawns, which are depleted in potassium, are grazed almost bare (Archer, 1972a and b). In addition to the lawns and roughs, patches of bare soil develop in areas where the horses often stand or walk (Odberg and Francis-Smith, 1976).

From an experiment Rogalski (1970) stated that horses preferentially graze certain areas of a field from their first day in that field and that these areas become overgrazed within a few days unless appropriate management is undertaken. However, the author did not state whether the field had been grazed by horses at any

time previously. When such a pattern of lawns and roughs is established in a field it persists for many years, reappearing even after the land has been ploughed, fertilised, sown with arable crops for two years and then reseeded as horse pasture (Archer, 1977). It may therefore be induced that certain areas of field are more likely to be grazed than others. The factors causing this are not known since no regularity has been found in the size, shape and location of these areas. In these circumstances horses move out of the grazing areas to excrete. If the reverse was true; horses excrete indiscriminately and avoid grazing near faeces, then excrement would be distributed randomly over the pasture giving the same picture as an intensively grazed cow pasture. Grouping excrement in certain areas of the field is a feature of adult horses kept in small fields (Odberg, 1969 and 1975). Young foals do not discriminate between lawns and roughs (Odberg and Francis-Smith, 1976) and free-ranging horses excrete indiscriminately in their home ranges with the exception of marking behaviour (Collery, 1974; Feist, 1971; Tyler, 1972; Welsh, 1973).

To maintain a balanced pasture for horses the land should be grazed by horses and cattle and also rested regularly (Archer, 1972b; Wallace, 1977). The cattle eat the long grass and excrete indiscriminately thus helping to restore an even potassium distribution. If pasture is fertilised with manure horses will graze indiscriminately until the scent wears off (Archer, 1977). Faeces can be removed from paddocks to keep the pasture 'clean' but this must be done within 24 hr of deposition to be effective

(Archer, 1978). On the other hand urine does not affect the palatability of herbage to horses.

2:3:2 Grazing behaviour

In recent years grazing studies have been helped by the development of new recording techniques. An automatic device, the vibracorder, has been used successfully to record the grazing times of cattle over long periods (Ruckebusch and Bueno, 1973 and 1978; Stricklin, Wilson and Graves, 1976). The grazing behaviour of sheep living on large arid ranges has been studied using aerial photography (Dudzinski and Arnold, 1967; Dudzinski, Pahl and Arnold, 1969). In addition, improved methods of measuring the intake of grazing animals have been developed. Originally intake was measured by mowing herbage from a standard surface area in a paddock before the pasture was grazed. An identical area, but from a different part of the field, was mowed after the field had been grazed, and intake was estimated from the difference in weight of the mowings, (Johnstone-Wallace and Kennedy, 1944). However the use of chromic oxide and fistulated animals now provides more reliable results for horses, cattle and sheep (Crawford, Baker and Lieb, 1971; Jamieson and Hodgson, 1977; McGuire, Bradley and Little, 1966).

Early studies on grazing behaviour concentrated on cattle and sheep (Hancock, 1954; Johnstone-Wallace and Kennedy, 1944; Tribe, 1955). More recently reviews on grazing behaviour have also included work on the horse (Arnold and Dudzinski, 1978; Kiley, 1974; Kiley-Worthington, 1977). Many factors, both internal and external, interact to affect the grazing animal and consequently the pasture on which it is grazing. External factors are

numerous and these include the following; weather, season, management, the palatability, structure and abundance of the sward, digestibility and monotony of the sward, presence of faeces, social factors and the size of the field. Some internal factors that affect grazing behaviour are the selectivity of the grazing animal, its nutritional requirements, bite size and frequency, as affected by the animal's hunger and its physical limitations, together with its age, sex and past experience.

2:3:2:1 External factors affecting grazing behaviour

2:3:2:1:1 Weather

Extremes of weather such as strong heat, wind or rain reduce the time that horses spend grazing (Martin-Rossett, Doreau and Cloix, 1978; Rogalski, 1975a). Similarly windy weather and heavy rain reduce the grazing time of cattle (Rogalski, 1975b; Ruckebusch and Bueno, 1978).

2:3:2:1:2 Season

Season affects the grazing animal through seasonal changes in the weather and the state of the sward. Grazing at night is more common during the summer than the winter in cattle, sheep and ponies (Hafez et al., 1969; Tribe, 1949; Tyler, 1972). The beginning and end of daily grazing periods of cattle are correlated with the times of sunrise and sunset (Ruckebusch and Bueno, 1978). Thus in winter cattle start grazing later and finish earlier than in summer. In spring, when grass is abundant, cattle spend less time grazing than at other times of the year (Ruckebusch and Bueno, 1978).

2:3:2:1:3 Management

Several factors vary between different management systems. Some of those affecting grazing behaviour are the following; the type of sward, the size of the field, the nutritional demands on the animal and the social grouping of the animals. These points are discussed in the following sections.

2:3:2:1:4 The palatability, structure and abundance of the sward

In a test involving over 30 different plant species and seeds-mixtures it was found that horses preferred grazing a clover-rich seeds mixture, pasture varieties of perennial ryegrass, timothy, cocksfoot, dandelion, ribgrass and yarrow to the other species present. The least palatable plants were red clover, brown top, red fescue and some herbs (Archer, 1971 and 1973).

The structure of the sward affects the quantity of herbage taken in at every bite. Dense leafy herbage with a low stem content provides the maximum intake per bite (Stobbs, 1973b). Fertilisers increase the intake of a grazing animal because they encourage dense, leafy growth of the sward with little stem (Stobbs, 1973a). To compensate for a decrease in the quantity of available herbage grazing calves, lambs and horses increase their grazing time and bite frequency (Jamieson and Hodgson, 1977; Rogalski, 1970). As the quantity of available herbage increases so does the intake of the grazing animal (Engels, Malan and Baard, 1974). This presumably has an upper limit. The daily intake of grazing sheep has an asymptotic relationship with the amount of food available (Gibb,

1977) whereby progressive increases in available food result in progressively smaller increases in intake.

2:3:2:1:5 Digestibility of the sward

The digestibility of herbage is increased with the use of fertilisers and is highest in early summer when the leaves are growing and the flowers not yet formed (Stobbs, 1973a). Herbage organic matter, digestibility and intake by grazing calves has a close linear relationship (Hodgson, 1968). Similarly wethers increase their forage consumption as the digestibility of the forage increases (Sosulki, 1960). A larger intake is associated with a lower fibre content in the diet and more rapid movement of the digesta through the gut (Campling, 1966; Blaxter, Graham and Wainman, 1956). This is reflected by longer grazing times or by increased bite size where the structure of the sward permits it.

2:3:2:1:6 Monotony of the sward

Since horses readily eat certain plant species in preference to others it might be assumed that an ideal horse pasture could be sown using only those species for which horses had shown a distinct preference. However horses, cattle and sheep often eat dead leaves, hedgerows, coarse herbage and soil in preference to rich pasture (Ellison, 1948; Fraser and Brownlee, 1974; Kiley-Worthington, 1977) indicating a need for either variety in the taste and texture of food or more fibre than that available from a fertilised pasture.

2:3:2:1:7 The presence of faeces

The effect of faeces on the grazing behaviour of horses has been

described in Section 2:3:1. Cattle are also averse to grazing near their own faeces. In a close-folding system the faeces passed by one cow per day is estimated to affect 88 sq. ft of the paddock at the next grazing (MacLusky, 1960). Therefore with successive grazings the area of a paddock that is actually grazed declines; eighty-one per cent is reported to be grazed at the first grazing and only forty-three per cent by the third grazing (Proctor, Hood, Ferguson and Lewis, 1950). Such wastage of pasture is reduced if different animal species are grazed on the same land, since the aversion is only to faeces passed by conspecifics (Kiley-Worthington, 1977). In contrast sheep do not usually reject grass round their faeces or round cattle faeces (Arnold and Dudzinksi, 1978).

2:3:2:1:8 Social factors

Social facilitation can increase the grazing time of an animal. In an experiment by Tribe (1950) sheep given a small supplementary feed had shorter grazing times than unsupplemented sheep but when the two groups were mixed the former had grazing times similar to those of the unsupplemented group. However there is no additional information on the effect of social factors on grazing behaviour.

2:3:2:1:9 The size of the field

An increase in the size of the field increases the distance a grazing animal travels each day (Sheppard, 1921). Presumably there is a limit to this at both ends of the scale. Time spent walking is correlated to the grazing time of cattle (Ruckebusch

and Bueno, 1978) and is larger on a 3 ha field than a 0.5 ha field. Furthermore, cattle pastured on the 3 ha field had a typical circadian pattern of grazing which disappeared when they were kept on the smaller area (Ruckebusch and Bueno, 1978). It is necessary to stock grazing animals at the optimum density. If too many horses are kept on a small field they become restless and aggressive but if there are too few animals then some pasture is wasted (Rogalski, 1970).

2:3:2:2 Internal factors affecting grazing behaviour

The sex, age and past experience of an animal may all affect its grazing behaviour although there are no reports of this in domestic ungulates. In an experiment on monozygotic twin cattle it was shown that the greatest source of variability in grazing behaviour was individual differences in animals (Hancock, 1950).

2:3:2:2:1 The selectivity of the grazing animal

Different animal species select different plants or parts of plants while grazing. Sheep eat leaves in preference to stems and select plant material with the highest nitrogen content (Arnold, 1960a). Horses select the short young growth of plants and also show a preference for the more fibrous grass species that cattle reject (Archer, 1977). Also horses graze the higher carbohydrate grasses in a mixed pasture while cattle select those with a lower carbohydrate content (Kozlowski, 1974). Merino sheep and cattle, grazing together on a variety of different pastures, have consistently different diets (Dudzinski and Arnold, 1973). However the diet composition of different breeds of sheep is similar (Engels

et al., 1974). Differences between species in diet selection may be due to the animal's mechanical ability to be selective (Dudzinski and Arnold, 1973). The ability of sheep to select preferred plant species from a pasture depends on their senses of smell, taste and touch but not sight (Arnold, 1966a and b).

2:3:2:2:2 Nutritional requirements of the grazing animal

Grazing animals that are fed a dietary supplement decrease their grazing time in inverse proportion to the amount of food given (Sarker and Homes, 1974). Correspondingly, if the nutritional requirements of an animal increase the animal increases its grazing time to compensate. Ewes carrying twin lambs graze for longer than ewes with singletons (Tribe, 1950) and pregnant mares spend longer grazing than immature stallions (Rogalski, 1975a). Nursing lambs eat less than weaned lambs of the same age and ewes reach a maximum daily intake of herbage in their third week of lactation (Gibb, 1977).

2:3:2:2:3 Bite size and frequency

There are natural limits to the maximum bite size and frequency of a grazing animal which depend on the animal's anatomy and physical ability, but the greatest variation in bite size is due to the state of the sward (Chacon and Stobbs, 1977) and in cattle the bite size decreases as a grazing period progresses. Rogalski, (1975a) has suggested that the higher bite frequency of Arab stallions compared to thoroughbred mares is a better adaptation to grazing but it may simply be an indication of a smaller mouth in the Arab.

2:3:2:3 Time spent grazing

Until the 1940s it was thought that grazing animals - cattle, sheep and goats - rested from dusk to dawn and that grazing, urinating and idling only occurred during daylight hours (Cory, 1927). During experiments over periods of 24 hr however it was discovered that grazing animals are active during a large part of the night (Castle, Foot and Halley, 1950; Johnstone-Wallace and Kennedy, 1944; Tribe, 1949). Reports of daily grazing times of cattle vary, according to conditions, between 6.08 hr and 9.9 hr (Gary, Sherritt and Hale, 1970; Ruckebusch and Bueno, 1978; Waite, MacDonald and Homes, 1951). Daily grazing times of sheep range from 6 hr to 13 hr depending on the state of the sward (Allden and Whittaker, 1970) while ponies spend up to 16 hr a day grazing (Tyler, 1972). On good abundant pasture a grazing animal may be able to consume its daily requirements in a short time after which the animal can be moved to a stable or yard to preserve the pasture (Rogalski, 1970). However if the quality or quantity of available pasture decreases, animals increase their daily grazing time to compensate (Gibb, 1977). Nevertheless there is an upper limit to the amount of time an animal can spend grazing presumably due to fatigue (Tribe, 1950) and if the sward deteriorates too much animals are unable to maintain liveweight by increasing grazing time beyond this limit (Arnold, 1960b).

The daily grazing time of sheep, cattle and horses occurs in several grazing periods (Castle, Foot and Halley, 1950; Martin-Rossett et al., 1978; Tribe, 1955). Grazing animals usually start a major grazing period soon after dawn and end one at dusk

(Ruckebusch and Bueno, 1978; Tyler, 1972).

The effect that a grazing animal has on the sward composition is to reduce the growth and reproductive performance of the most palatable plants (Rickard, Uresk and Cline, 1975). Therefore, since a variety of plant species are necessary in the diet of grazing animals and different animal species show a preference for different plants, then mixed grazing can help to maintain an even balance of plant species in the sward. Such benefits of mixed grazing on productivity are emphasised in a recent review on grazing behaviour (Kiley-Worthington, 1977).

2:3:3 Feeding behaviour

The stabled animal is spatially separated from conspecifics, sheltered from the weather and has no choice in either the quantity or the quality of its diet. Stalled cattle and sheep are less selective when eating cut herbage than when they are grazing (Hardison, Reid, Martin and Woolfolk, 1954; Weir and Torell, 1959) and the feeding behaviour of stalled and stabled animals seems less complex than grazing behaviour.

2:3:3:1 Rate of eating

Horses eat high calorie low bulk food such as oats and horse cubes faster than high fibre foods - hay, cut grass and silage (Meyer, Ahlswede and Reinhardt, 1975; Ruckebusch, Vigroux and Candau, 1976), taking 65 min to eat 1 kg hay but only 15 min to eat 1 kg oats. The faster uptake is achieved by a faster rate of chewing with less displacement of the lower jaw (Ruckebusch et al.,

1976). The palatability of food does not affect the rate of uptake by cattle (Cooke, 1977) but the rate of eating decreases as a meal progresses (Suzuki, Fujita and Shinde, 1969).

2:3:3:2 Daily duration of feeding behaviour

If horses are required for work it is advantageous to reduce their daily feeding time by supplying a proportion of concentrate food in their diets. The daily feeding time of horses receiving different diets varies from 14.4 hr on a diet of hay to 5.6 hr on a diet of oats (Ruckebusch et al., 1976). The proportions of concentrate and bulk foods in a diet need to be balanced carefully taking into account the other activities of the horse to prevent boredom. Ponies spend more time chewing wood and eating faeces when fed a concentrate diet than when fed hay only (Willard, Willard and Baker, 1973).

2:3:3:3 Diurnal distribution of feeding behaviour

The diurnal distribution of the feeding behaviour of horses is related to the type of diet, the quantity of food given and the times at which food is supplied (Doreau, 1978; Ruckebusch et al., 1976). Ruckebusch and his co-workers have claimed that most feeding takes place during the day and that approximately one third of a horse's daily feeding time occurs at night. However horses have their longest meal immediately after food is supplied even if it is given ad lib. (Doreau, 1978). Therefore the smaller proportion of feeding behaviour recorded during the night by Ruckebusch as opposed to daytime feeding may have been a result of the times when food was provided - 08.00 hr and 18.00 hr and not

a true difference between day and night.

2:4 Mother-infant relationships

Ungulate species have been classified as one of two types - 'hiders' and 'followers' - depending on the type of mother-infant relationship that they show (Walther, 1961). The 'hiders' are species found in habitats with vegetational cover in which the offspring hide for long periods (Lent, 1974). The duration of the hiding phase varies from 4 days for feral goats (Rudge, 1970) to 4 months for reedbuck (Jungius, 1970). During this phase the mother returns to her infant two to three times a day for nursing and care sessions (Lent, 1974). Most cervid species, the gazelles and many antelopes are 'hiders' (Lent, 1974). In contrast, the 'followers' are found in open habitats. Many of these species are migratory and they include the equids, ovids and large bovids (Shillito-Walser, 1977a). The 'follower' type species maintain close and frequent contact between mother and infant from the first day post-partum and there is a complete absence of any 'hiding' phase (Walther, 1961). Differences between the 'follower' and 'hider' type species are found in the development of mother-infant bonds, maternal behaviour, nursing behaviour and in the infant's response to alarm. These points have been discussed in a comprehensive review on this subject (Lent, 1974).

2:4:1 Mother-infant bonds

The imprinting of the mare begins as soon as she licks her foal or the foetal fluids (Rossdale, 1968; Tyler, 1972) but it is not known how long imprinting takes. However it takes 2-3 days

for the foal to become imprinted and during this time the mare chases conspecifics away from her foal to ensure correct imprinting (Klingel, 1969c; Tyler, 1972).

Most free-ranging equids allow their foals to nurse until shortly before the next foal is born (Tyler, 1972; Welsh, 1975) and when weaning does occur amongst the non-territorial equids it does not destroy the mother-infant bonds. These remain intact and offspring stay in their mother's family group until they reach adolescence, (Klingel, 1969d; Tyler, 1972; Welsh, 1975).

2:4:2 Maternal behaviour

During the final stages of pregnancy females become physiologically and behaviourally ready to respond to their new born offspring (Shillito-Walser, 1977). Some mares look for their foal even before the foetus has been expelled and this may indicate that the mare is physiologically and behaviourally ready for the foal. Immediately after parturition mares lick their foals vigorously (Rossdale, 1968). Female goats also lick their new born young (Blauvelt, 1954) and this stimulates the respiration, circulation and muscle tone of the kid and so hastens the kid's efforts to stand. It is thought that after the mare has licked her foal she is able to distinguish it from other foals (Tyler, 1972). Eventually mares recognise their foals through their visual and olfactory senses and also they distinguish their foals' calls from the calls of other foals (Houpt, 1979).

Foals show sucking movements even before they stand (Phillips-Powell,

1978) and mares help their foals to find the udder by standing still and sometimes pushing the foal towards the udder (Tyler, 1972). In precocious mammals, such as the foal, maternal behaviour is less significant than in the altricial mammals (Shillito-Walser, 1977). However it is important that the behaviour of the mare and foal fit together to permit the foal to take advantage of the mare's milk and the protection provided by the presence of adult animals.

2:4:3 The behaviour of foals

Foals are precocious offspring. They stand 57 min after birth and suck within 111 min of birth (Rossdale, 1967). During its first day of life a foal does not distinguish between its dam and other mares (Powell, 1978) and will follow any large moving object. However, by the age of 2-3 days foals recognise their dams and follow them closely (Klingel, 1969a; Feist, 1971); the foals being largely responsible for maintaining contact with the dam (Feist, 1971). They use both visual and olfactory senses to identify their dams but do not discriminate between the calls of different mares (Houpt, 1979).

From the first day post-partum foals play (Powell, 1978). At first they play alone but by the age of four weeks they play mutually (Tyler, 1972), most play being in the early morning or the evening (Feist, 1971; Schoen et al., 1976). Colts spend more time playing and play more vigorously than fillies (Schoen et al., 1976; Schafer, 1975).

There is little aggression between foals and normally dominance hierarchies develop slowly (Tyler, 1972). However, orphan foals, kept in groups of two or three animals, quickly develop a hierarchy and they suck from the milk machine in rank order (Glendinning, 1977). A submissive expression shown only by foals was first described by Zeeb (1959). This has been called 'snapping', 'champing' and 'grinning' and will be referred to as 'grinning' here. It is shown in a variety of contexts but usually in the proximity of an adult (Tyler, 1972).

Foals start to graze during their first week of life (Rashek, 1976; Tyler, 1972) and they increase their grazing time as they grow older (Martin-Rossett et al., 1978). They also lick the soil and chew wood, trees and hedges from an early age (Rogalski, 1973; Veselovsky and Volf, 1965).

A characteristic behaviour pattern of foals is coprophagia (Francis-Smith and Wood-Gush, 1977; Klingel, 1972b; Rashek, 1976; Tyler, 1972). It was originally thought that the presence of Strongyloides westeri eggs in foals' faeces indicated that foals ate the faeces of adult horses (Taylor, 1954), however it has since been shown that strongyloides eggs are passed to the foal in its dam's milk (Lyons, Drudge and Tolliver, 1973). Coprophagia is normally shown by foals up to one month old and its occurrence after this age is less frequent (Martin-Rossett et al., 1978). By eating their mothers' faeces foals obtain bacteria essential for the digestion of fibre. Correspondingly at one month of age changes occur in foals' faeces that indicate the beginning of caecal and large intestinal fermentation of fibre

(Baintner, Ocsag and Fulop, 1971).

2:4:4 Nursing behaviour

Nursing periods are described in the literature as occurring in bouts. Foals nurse with frequent brief interruptions in nursing activity (Tyler, 1972) and it is not always clear whether workers have included the duration of these pauses in bout duration. In species that nurse frequently the limits of a bout are not always clear. Therefore it must be remembered that the frequencies and duration of nursing bouts described in the literature are not accurate.

In comparison with other 'follower' types of offspring foals nurse frequently. During the first week post-partum foals nurse approximately four times per hour (Bouwman and Schee, 1978; Tyler, 1972) whereas lambs of the same age nurse only 15 times per 12 hr (Ewbank, 1964). Differences in nursing frequency between breeds of foals have been reported (Rogalski, 1973) although it was not stated whether or not these foals were of the same age. Less time is spent in nursing as the foals grow older (Barmincev, 1960; Martin-Rossett et al., 1978). The milk production of lactating mares increases to a peak in week 10 post-partum (Bouwman and Schee, 1978) and older foals are able to consume more by sucking faster while nursing (Rogalski, 1973). Daily peaks in the nursing activity of pony foals occur between 08.00 hr and 10.00 hr and between 06.00 hr and 07.00 hr (Schoen et al., 1976). However there are no other reports in literature of diurnal fluctuations in nursing activity.

Certain behaviour patterns have been recorded in connection with nursing behaviour. Nursing behaviour is almost always initiated by the foal (Feist, 1971; Tyler, 1972). When foals approach their dams to nurse they often walk along one side of her, push their way under her neck and walk down the other side to the udder (Feist, 1971; Rashek, 1976). This movement is called 'heading-off' and it encourages the mother to stand still (Tyler, 1972). 'Pushing' the udder with the muzzle is also a common feature of nursing activity (Rashek, 1976; Tyler, 1972) and encourages milk flow in the same way that oxytocin does (Zaks, 1962) but it is painful to the mother and she may threaten her infant to discourage it from nursing. New Forest pony mares bite and kick their foals, avoiding them and stamping the ground when 'pushing' is painful (Tyler, 1972). Foals that are either frustrated in their attempts to nurse or cannot reach the udder for any reason paw the ground or paw and kick their dams (Rashek, 1976; Tyler, 1972).

Various ways in which females help their offspring to nurse have been described. Pony mares stand still and flex the leg on the side away from the foal (Tyler, 1972). Wild ass mares hold their hind leg away from the body and lift it up while the foal nurses (Rashek, 1976) and feral horse mares step forward with their fore-legs, leaving their hindlegs stationary to make the udder more accessible to the foal (Feist, 1971). The occurrence of nursing after a disturbance or after foals have been resting is common (Schoen et al., 1976; Tyler, 1972).

2:5 Resting behaviour and sleep

The sleep of horses was first studied by Steinhart in 1937. He observed that sleep occurs several times during each 24 hr period and that recumbency is essential for the occurrence of deep sleep. More recently Steinhart's work has been confirmed by studies using electrocorticography and electromyography (Ruckebusch et al., 1970; Ruckebusch, 1972). Horses are the most alert of the common farm animals and spend 88% of each 24 hr period in a state of wakefulness. Four sleep-wakefulness states; alert-wakefulness, drowsiness, slow-wave sleep and paradoxical sleep; occur in the horse and for the last mentioned stage to occur it is necessary for the horse to lie down.

Changes in the environment, for example diet, accommodation or social grouping of an animal, cause changes in the animal's circadian sleep profile (Ruckebusch, 1976). In particular, the duration of paradoxical sleep is reduced and an animal's adaptations to its environment is reflected in the daily duration of paradoxical sleep.

2:6 Recording techniques used in the study of behaviour

2:6:1 Observational techniques

In an observational study of behaviour, as in any experiment, careful design is essential to maximise the validity of the results. An ethogram aids quick and unambiguous recording (Ewbank, 1967) and various recording techniques can be used depending on the aim of the experiment and the facilities available. These methods have been described in a comprehensive article on the subject (Altmann, 1974).

2:6:2 Equipment used in behavioural studies

Since the 1950s a variety of equipment has been designed to record the feeding and grazing behaviour of cattle, sheep and horses over periods of 24 hr. Such equipment is designed to record an event that occurs continuously while an animal is eating. The feeding behaviour of stalled animals has been studied using a record of jaw movements (Ruckebusch et al., 1976) or changes in the weight of the manger (Metz and Borel, 1975). However, grazing recorders need to be more specialised than the equipment used in stalls. They must be robust, lightweight, compact and portable. Grazing times have been recorded using changes in the position of the animal's head (Canaway, Raymond and Taylor, 1955; O'Shea, 1969) or jaw movements (Stobbs and Cowper, 1972). Telemetry is unsuitable for recording the behaviour of animals at pasture. Until now the most successful grazing recorder is one that incorporates a vibracorder - the instrument used for logging operating times of lorries - in its design (Allden, 1962). The vibracorder contains a freely oscillating pendulum that transmits the jerky movements of a grazing cow's head onto a waxed chart rotated by a 24 hr clock. An adapted vibracorder has been used to record both grazing times and ruminating times of cattle (Ruckebusch and Bueno, 1973).

2:7 Conclusion

Finally the horse, since its domestication in 2 500 B.C. (Short, 1975) has had a close association with man and has been a focus of work, art and sport. In spite of this it is only recently that much attention has been paid to the ways in which horses behave.

in domestic conditions and to optimum methods of management. From the foregoing literature review it can be seen that while the behaviour of feral horses has been studied quite thoroughly there are many gaps in the information on domestic horses. Unfortunately for economic reasons domestic horses are rarely available for experimental purposes only. Thus behavioural research usually has to compete with other demands on the subjects, and it is rarely possible to manipulate materials freely to create ideal experimental conditions. This may be one reason why certain aspects of the behaviour of domestic horses have been studied more than others. Some problems have been illuminated such as the grazing and eliminative patterns of domestic horses but even these require further study before they can be understood. Other aspects, such as the behaviour of foals during their early months have been neglected and little is known about the complex behaviour of the grazing horse. Most behavioural studies rely on human observation to record data and are labour extensive. With the use of suitable automatic recording techniques, the style of experiment could be changed and more data could be collected with less effort.

3 MATERIALS

3 Materials

All the experimental work was carried out using the facilities at the University of Edinburgh Veterinary Field Station. Several of the horses and some of the fields were used in more than one experiment.

3:1 Subjects

The subjects could be divided into three groups. There were eight thoroughbred brood mares and their offspring, three juveniles (two males and one female) and two geldings (Table 1A, B and C).

All the mares, except Gay, arrived at the Veterinary Field Station in January 1974. Emma, Kirsty, Melody, Polly and Willow were kept in Field 4 (Figure 1) while Flatspin and Nyse were accommodated in the animal hospital. Nyse and Flatspin joined the other brood mares in July 1975 and January 1976 respectively. Gay arrived at the Field Station in April 1975. The mares were kept as one group except when they foaled. During their last two weeks of pregnancy mares were housed in stables on the stable yard (Figure 1). After foaling they and their foals were pastured with the other mare-foal pairs but were kept separately from the barren mares. When the foals had been weaned all the mares were kept in one group again and the foals were then kept separately.

Willow was removed from the group in April 1975 and Nyse was removed in December 1976.

The mares were weighed and had blood samples taken once a week and were also closely observed for oestrous behaviour. If a mare was

TABLE 1 The subjects used in the experimental work

A Brood mares

Name	Year of birth	Height at withers, cm.	Foals sired by 'Sunny Duel' 1975 Name	Sex	1976 Name	Sex	1977 Name	Sex
Emma	1970	152	-		Iona	F	Angel	F
Flatspin	1967	163	-		-		Bashful	F
Gay	1965	155	Gay Soleil*	F	-		Caliban	M
Kirsty	1966	168	Sundance	F	-		Captain Hook	M
Melody	1966	152	Samson	M	Chance	F	Lucky	M
Nyse	1968	152	Toby	M	Poppy	F	-	
Polly	1968	155	-		Tara	F	Jemma	F
Willow	1962	155	-		-		-	

* Sired by 'Solar Topic'

TABLE 1 (cont.)

B Juveniles

Name	Year of birth	Height at withers, cm	Sex
Albert	1974	140	M
Dux Deluxe	1974	145	F
Passion	1974	147	M

C Geldings

Name	Year of birth	Height at withers, cm	Sex
Adam	1961	166	M
Oakleigh	1971	147	M

in oestrus at any time between April and June she was mated with the thoroughbred stallion - Sunny Duel.

The juveniles - Albert, Dux and Passion - were born at the Field Station in 1974 and had been kept as a group since then together with the barren mares in Field 1 from May 1976 until August 1976.

The geldings were riding school horses. They were accommodated in the stable yard between mid-September and June every year and were used regularly for riding. In July and August they were pastured on Fields 1, 2, 3 or 4 with the other riding school horses.

3:2 Accommodation

The animals were accommodated in either the stables, the stalls or one of the fields (Figure 1).

The fields, which were ploughed and sown with a seeds mixture (ryegrass, timothy and whiteclover) in different years (Table 2) were grazed by cattle, sheep and horses and were rested at times. Water was available ad lib. and each field was sheltered along one or more sides by a strip of woodland.

The stalls were five similar areas 2.8 m x 1.8 m (Figure 2). They were separated from one another by wooden partitions 1.9 m high and had a cobbled stone floor. In these the horses were tied so as to be able to lie down but not turn round or see out. The stables which were 6 m x 4.2 m looked out onto the stable yard, had concrete flooring and allowed the horses to move about inside them.

TABLE 2 The surface areas of the fields and the dates when they were sown with a grass seeds mixture

Field	Area, ha	Year sown
1	1.3	1973
2	1.3	1975
3	1.3	1976
4	1.3	1974
5	1.9	1970
6	3.9	1976
7	6.4	1974

4 A PILOT STUDY TO INVESTIGATE THE BEHAVIOUR OF MARES AND THEIR FOALS DURING THE FOALS' FIRST EIGHT WEEKS OF LIFE

4 A pilot study to investigate the behaviour of mares and their foals during the foals' first eight weeks of life

4:1 Introduction

The normal and abnormal perinatal behaviour patterns of domestic mares and foals are well documented (Rossdale, 1967, 1968, 1969 and 1970). However, little attention has been paid to the subsequent development of the foals. Such aspects as nursing behaviour, the onset of feeding behaviour, the mare-foal relationship and the foal's relationship with conspecifics are not reported in the literature. Since this was a new area of research it was known neither which observation techniques would be suitable nor how much data could be recorded during observation periods. It was therefore decided to run a pilot study to acquaint the observer with the behaviour of foals and thus establish the optimum design for this type of experiment.

4:2 Materials and methods

4:2:1 Subjects

Four mares - Emma, Polly, Melody and Nyse and their foals were the subjects (Table 3). Each mare had been treated with anthelminthics and was believed to be worm-free at parturition.

TABLE 3 Details of the mares and foals

Mare	Foal	Date of Birth	Sex	Weight on first day after birth, kg	
				Foal	Mare
Emma	Iona	3.4.76	F	45	504
Polly	Tara	7.4.76	F	49	528
Melody	Chance	26.6.76	F	53	526
Nyse	Poppy	9.7.76	F	33	395

4:2:2 Management of the subjects

4:2:2:1 Stabling

Each mare was housed in a stable from two weeks before her expected date of parturition until the time when she was turned out to grass with her foal. While stabled each mare received a daily food allowance of 5 kg oats, 1 kg bran and 7 kg hay which was divided into two equal portions and supplied at 08.00 hr and 16.00 hr, the foals being able to share the mares' food. Wheat straw was used as bedding in the boxes and water was available ad lib.

4:2:2:2 Pasture

On windless, dry days the animals were pastured in Field 3. Initially the animals spent a few hours a day in the field but after a while they were left out day and night (Table 4).

4:2:2:3 Routine recordings

The foals were weighed, radiographed and photographed and their heights were measured on the first day after birth. These recordings were subsequently made weekly.

Every third or fourth day post-partum each mare was taken to a stallion and observed for oestrous behaviour, and if in oestrus she was mated with the stallion on alternate days (Table 5).

TABLE 4 The dates when the mares and foals were A) first turned out to grass, B) pastured continuously

	A	B
Emma	21.4.76	-
Polly	21.4.76	-
Melody	5.7.76	17.7.76
Nyse	11.7.76	28.7.76

TABLE 5 The dates during the experiment when the mares were mated with the stallion

Emma	Polly	Melody	Nyse
26.4.76	7.5.76	-	19.7.76
28.4.76	-	-	21.7.76
17.5.76	-	-	-
19.5.76	-	-	-

4:2:3 Observation periods

Each observation period lasted for 30 min and eighteen observation periods, arranged to cover the time between 08.00 hr and 17.00 hr were made on each mare-foal pair during the weeks shown in Table 6. Observation of foal behaviour began during the first 08.00 hr to 17.00 hr period after the foal's birth. The exception to this was for Melody and Chance when observations began on the eighth day post-partum. However observations were not made after a mare-foal pair had been out of the stable or field for any reason until the following 08.00 hr to 17.00 hr period.

4:2:4 Behavioural recordings

4:2:4:1 Definition of behaviour patterns

Fourteen mutually exclusive behaviour patterns that foals perform were listed. Of these twelve are shown by mares as well (Table 7), but nursing and coprophagia were specific to the foals.

4:2:4:2 Recording methods

Recordings were made with the aid of a clockwork stop-watch and a cassette recorder. The method of intermittent observations (Hull, Lofgreen and Meyer, 1960) was used to record the behaviour patterns of the mare and the foal at 15 sec intervals. This was used because information was required on both the foals' and the mares' behaviour but it was felt that it would be impractical to make a

TABLE 6 The weeks post-partum when observations were made

Emma	Weeks 1 to 7
Polly	Weeks 1 to 6
Melody	Weeks 2 to 8
Nyse	Weeks 1 to 6

TABLE 7 The activities that were performed by mares and foals

1.	Nursing	The foal reached up, with its muzzle, into the mare's pelvic region
2.	Coprophagia	The foal explored, bit and chewed faeces
3.	Eating hay	The animal bit, chewed and swallowed hay
4.	Eating oats	The animal bit, chewed and swallowed oats and bran
5.	Grazing	The animal bit, chewed and swallowed grass
6.	Drinking	The animal drank from the water supply
7.	Standing	The animal stood still showing no other activity
8.	Moving	The animal moved for four or more paces
9.	Exploring	The animal nosed, sniffed, licked or mouthed objects
10.	Grooming	The animal groomed parts of its body with its mouth, leg or against a solid object.
11.	Urinating	The animal stood in the urinating position and urinated
12.	Interacting	The animal approached, watched, explored, groomed, threatened or avoided another animal
13.	Resting standing	The animal stood with its neck horizontal and with any of the following features: i) eyes half closed ii) lower lip hanging

TABLE 7 (cont.)

	iii)	ears deviated laterally
	iv)	one hind leg bent
14. Resting lying	The animal was recumbent	

continuous recording of both. Short intervals were chosen because accurate information on the foals' nursing behaviour was required.

The reactions of foals to faeces deposited by their dams were recorded by noting the following points:

1. Whether or not the foal reacted to faeces deposited by its dam.

2. The duration of time between the mare defaecating and the foal approaching the faeces

3. The duration of time for which the foal sniffed and pawed the faeces.

4. The duration of time for which the foal bit and chewed the faeces.

4:2:5 Non-behavioural recordings

Samples of foals' faeces were collected daily from the foals' recta except when foals were scouring when collection was impossible.

4:2:6 Analysis of results

4:2:6:1 Statistical analysis

A paired 'Student's t-test' (Bailey, 1975) was used to compare the significance of differences in the mean hourly duration of nursing activity between the weeks post-partum.

4:2:6:2 Analysis of faeces

The samples of faeces were analysed for their fibre content using the method described in the Appendix (Section 14:1).

4:3 Results

4:3:1 Nursing behaviour

Certain behaviour patterns shown by foals in connection with nursing behaviour are described below.

When foals approached their dams to nurse they often walked along one side of her, pushed under her neck,

walked down the other side to the udder and began to nurse. Nursing behaviour was composed of two behaviour patterns - nosing and sucking. Nosing was a teat-seeking behaviour pattern directed towards the udder although during their first few days of life foals also nosed in the mares' pectoral regions. When a foal grasped a teat with its lips it started to suck and sucked from the teats in a series of 'bursts' either changing teats on alternate 'bursts' or sucking from the same teat for several successive 'bursts'. On the first day post-partum foals sucked the air while they nosed and at times sucked the mares' tails, inside their hind legs and the sides of the udders before grasping a teat. Foals initiated all nursing behaviour by approaching their dams and starting to nose. At times they thrust their muzzles into - 'pushed' - the udder before and during sucking. This appeared to be painful to the mares and at times the mares avoided the foals when they approached to nurse.

Generally nursing and resting were closely related in the foals, the mean duration of the interval between nursing and resting being 195 $\pm$ 15 sec and between resting and nursing 165 $\pm$ 15 sec. However during periods of activity nursing could occur at intervals ranging from 15 sec to 2 hr in duration.

4:3:1:1 Time spent nursing

The mean hourly nursing duration decreased significantly as the foals grew older ($p \leqslant 0.05$, Figure 3). The foals nursed for 660 sec per hr in Week 1, but by Week 8 this value had decreased to 135 sec per hr. Nursing time included sucking and nosing behaviour. The foals often paused while nursing for intervals of several seconds when they dropped their muzzles from the udder. Nursing behaviour was only recorded if the foal was nosing or sucking at the 15 sec interval.

4:3:1:2 The mares' reaction to nursing behaviour

At first the mares were very tolerant of the foals' nursing behaviour. They helped the foals by standing still and by flexing the hind leg on the side opposite the foal to angle the teat towards the foal's mouth. However after the first week they appeared restless when the foals approached to nurse. They hindered or 'resisted' nursing behaviour by stepping away from the foal, biting, kicking, lashing with their tails and by lifting the hind leg on the side from which the foal was nursing. This 'resistance' occurred less often during the third and fourth week and thereafter hardly at all, although it was not recorded quantitatively. When frustrated in their attempts to nurse the foals cantered round their dams, kicked them or pawed the ground.

4:3:2 Eating behaviour

As the foals were pastured at different ages and for different lengths of time, it was not possible to compare changes in the times spent eating hay, eating oats and grazing as the foals grew older. However, since each foal was given the same management as its dam, the mean of each foal's total eating time, expressed as a percentage of its dam's total eating time, was plotted against the foal's age (Figure 4). During the first week the foals rarely ate but their eating time increased significantly from the first to the fourth week ($p \leqslant 0.01$) and then remained at approximately 40 per cent of their dams' eating time. Thus between four and seven weeks post-partum the mean duration of eating behaviour recorded from the mares was 4 hr 45 min and 2 hr 0 min from the foals during nine hours of observation.

4:3:2:1 Eating hay and oats

From the first day after birth the foals nosed, mouthed and chewed hay and then dropped lumps of chewed hay without swallowing it but by the eighth day post-partum (Table 8) each foal had eaten hay. This was characterised by a more regular biting and chewing of hay which was then swallowed. They had all eaten oats by the nineteenth day after birth (Table 8).

TABLE 8 The age, days, when foals were first observed to A) eat hay B) eat oats

	A	B
Iona	7	13
Tara	8	19
Chance	8	15
Poppy	3	17

4:3:2:2 Grazing behaviour

All the foals started to graze within 15 min of being turned out to grass, at 2 days or more after birth.

4:3:3 The reactions of foals to mares' faeces

During the experiment mares were observed to defaecate on 129 occasions. Foals did not react to 88 of these, explored 16 and ate from 25 of the piles.

4:3:3:1 Coprophagia

A total of 25 incidents of coprophagia were observed, (Table 9). In 17 of the cases the foals approached the faeces as soon as the mares had defaecated and in three cases less than 30 sec elapsed before the foal approached the faeces. The maximum time that a foal took to react was 345 sec. An incident of coprophagia began when a foal started to explore or bite its dam's faeces, and ended when the foal moved away from the faeces. However, the incident was not recorded as coprophagia if the foal did not bite the faeces before moving away. In 18 cases the foal bit the faecal pile within 15 sec of approaching it and in seven cases it explored the faeces for between 15 sec and 75 sec before biting (Table 10). In order to bite the faecal pile the foals bent their knees to reach it then bit it and held their muzzles in contact with the faeces for up to 10 sec, appearing to press their muzzles into it during this time. They then straightened their legs, and chewed slowly with

TABLE 9 The number and duration of incidents of coprophagia

Foal	Age when coprophagia was first and last seen	No. of incidents	Mean duration	Range in duration
Iona	11-32 days	4	169 sec	105-240 sec
Tara	3-20 days	12	170 sec	60-285 sec
Chance	10-31 days	5	125 sec	75-210 sec
Poppy	6-20 days	4	161 sec	75-240 sec

TABLE 10 The duration of time A) between the mare's defaecation and the foal's approach to the faeces B) for which the foal explored the faces before biting

A		B	
Time (sec)	No. of cases	Time (sec)	No. of cases
0 - 15	17	0 - 15	18
15 - 30	3	15 - 30	5
30 - 45	1	30 - 45	1
75 - 90	1	60 - 75	1
180 - 195	1		
300 - 315	1		
345 - 360	1		

pauses of up to 12 sec between chews. In six cases the foals continued chewing after they moved away from the faeces, but this time was not included in the incident length. The foals made between one and six bites per incident and there was nothing to suggest that foals did not swallow faeces. Foals ate from a faecal pile once only. There was one exception to this when Chance, at three weeks of age, was startled by a dog after eating faeces for 75 sec. She walked to her dam and stood beside her for 195 sec before returning to the same pile to eat for a further 30 sec. This was recorded as one incident lasting 105 sec (Plate 1).

Coprophagia was most frequent during the first three weeks after birth (Figure 5). The mares were observed to defaecate 61 times between and including, the first and last one eaten by foals. Foals ate from 25 (41 per cent) of these piles, explored nine piles (15 per cent) and did not react to 27 piles (44 per cent) (Table 11). Three of the 25 incidents of coprophagia were recorded in the field and did not appear to be any different to incidents recorded in the stable. Foals did not show any interest in their own faeces or in the faeces of other mares when they were together in the field. Occasionally mares sniffed their foals' faeces or the faeces of other mares but showed no other associated behaviour patterns.

TABLE 11 The number of mares' defaecations between, and including, the first and last one eaten by each foal and the foals' reactions

Mare	No. of defaecations	Foals' reactions		
		No. ignored	No. explored	No. eaten
Emma	19	11	4	4
Polly	19	6	1	12
Melody	14	8	1	5
Nyse	9	2	3	4

4:3:4 Analysis of foal's faeces

It was hoped that changes in the fibre content of the foals' faeces could be related to the age of the foals and the time they began to eat hay. However the number of faecal samples obtained was insufficient to give meaningful results for every foal scoured from Day 4 or 5 post-partum for more than a week and before scouring the foals' recta were often empty.

4:4 Discussion

4:4:1 Nursing behaviour

4:4:1:1 Nursing bouts

The nursing behaviour of various ungulate species has been well documented. In a review on this subject the variability of methods used to record nursing data is emphasised (Lent, 1974). Many workers have recorded nursing bouts without having defined a nursing bout. Some ungulate species nurse with frequent short interruptions in nursing behaviour and the limits of a nursing bout are not always obvious. It was felt that before the nursing behaviour of the foals could be recorded in bouts a nursing bout would have to be defined. However, no attempt was made to define a nursing bout at this stage. The subjective impression obtained was that foals nursed in bouts 60 to 90 sec in duration. Pauses that occurred in nursing behaviour varied in duration from a few seconds to 2 hr. Periods of nursing behaviour seemed to be grouped together into bouts with pauses less

than 30 sec in duration occurring within a bout and pauses more than 30 sec occurring between bouts. Due to the recording method used the pauses in nursing behaviour had a minimum duration of 15 sec and all durations were in multiples of 15 sec. Thus the frequent pauses of less than 15 sec in duration were missed and it was not possible to analyse the data statistically to test for the significance of differences in inter-nursing bout intervals and intra-nursing bout intervals.

4:4:1:2 The duration of nursing behaviour

The decrease in nursing duration as the foals grew older is consistent with the findings of other workers (Tyler, 1972; Martin-Rossett et al., 1978; Bouwman and Schee, 1978) and is discussed further in Section 5.

4:4:1:3 The mares' reactions to nursing behaviour

The 'resistance' shown by the mares to the nursing attempts of foals has also been observed in the New Forest ponies (Tyler, 1972). It is a result of the foals' 'pushes' which appear painful for the mares. 'Pushing', or bunting as it is sometimes called, occurs among all the ungulate species reported in the literature (Lent, 1974). This behaviour pattern encourages milk flow in the same manner as oxytocin (Zaks, 1962).

4:4:2 Eating hay, eating oats and grazing behaviour

The ability of foals to eat is probably related to the eruption of their teeth. This is discussed further in Section 5.

4:4:3 Coprophagia

Adult horses are reported to eat faeces as a result of hunger, boredom, or if they are on a high concentrate diet (Altmann, 1969; Feist, 1971; Willard, Willard and Baker, 1973). It is considered to be an abnormal behaviour pattern and adult horses normally have an aversion to eating faeces or eating near faeces (Odberg and Francis-Smith, 1977).

Foals of zebra, wild asses, ponies and horses have been observed to eat faeces (Taylor, 1954; Klingel, 1972; Tyler, 1972; Rashek, 1976) and it is suggested that this behaviour pattern provides foals' intestines with bacterial flora necessary for fermentation (Baintner, 1971). The incidence of coprophagia in foals is unknown. Tyler (1972) recorded coprophagia from foals between 1 day and 14 weeks of age and noted that it was most common at 3 to 4 weeks old. Zebra foals eat faeces during their first few days of life and wild ass foals eat faeces from the age of 6 days(Klingel, 1972; Rashek, 1976). The foals observed here ate faeces between 3 and 32 days post-partum and this was believed to be a normal part of their development, these results are discussed

fully elsewhere (see appended paper, Francis-Smith and Wood-Gush, 1977).

4:4:4 The recording method used

The recording method used was unsuitable for this type of study. Because the foals changed their behaviour patterns often, and many behaviour patterns lasted for only a few seconds, much information was lost. The poor experimental design compounded with the different management of each mare-foal pair meant that the information that was obtained was wasted because no two mare-foal pairs were treated alike.

The use of the stopwatch, cassette recorder and ethogram meant that behaviour patterns could be recorded quickly during the observation periods. It was felt that in future experiments with the use of these methods a continuous recording of the behaviour of the mare and the foal would be possible to study their behaviour over a period previously unreported.

5 A STUDY OF THE BEHAVIOUR OF MARES AND THEIR FOALS BETWEEN THE BIRTH AND WEANING OF THE FOAL

5:1 Introduction

Much of the data on the behaviour of foals comes from work on feral populations. However, domesticated mares and foals are often managed on a regular stable routine which is limited by the farm facilities and the stable conditions are very different to feral ones not only in the physical environment but also in social groupings and the type of food available to the horses. Differences between the behaviour of foals in the two environments might therefore be expected. Using the techniques learnt in Section 4 it was decided to carry out close observations on domesticated mare-foal pairs, between the birth and weaning of the foal which would provide information on the mother-foal relationship, the foal's feeding behaviour and its relationships with conspecifics. The data obtained would make an interesting comparison with other domesticated ungulates and feral horses and could help to improve the management of farm-bred foals.

5:2 Materials and methods

5:2:1 Subjects

Five mares - Polly, Gay, Emma, Kirsty and Flatspin - and their foals were the subjects (Table 12). Each mare had been treated with anthelminthics and was believed to be worm-free at parturition.

5:2:2 Management of the mares and foals

5:2:2:1 Stabling

Each mare was housed in a foaling box from two weeks before her expected date of parturition to the time when she was turned out to grass with her foal. While stabled the mares received a daily

TABLE 12 Details of the mare-foal pairs

Mare	Foal	Date of birth	Sex	Weight on first day post-partum, kg Foal	Mare	Date observation began
Polly	Jemma	15.4.77	F	58	553	15.4.77
Gay	Caliban	27.4.77	M	45	455	27.4.77
Kirsty	Captain Hook	29.4.77	M	64	693	30.4.77
Emma	Angel	30.4.77	F	44	510	30.4.77
Flatspin	Bashful	19.6.77	F	38	523	20.6.77

food allowance (Table 13) which was divided into three equal portions and supplied at 08.30, 12.00 and 15.30 hr. Wheat straw was used as bedding in the boxes and water was available ad lib. In the field the mares received a daily food allowance (Table 13) which was divided into two equal portions and supplied at 08.30 and 16.30 hr. The foals were able to share the mares' food in the stable and the field.

5:2:2:2 Pasture

During the second week after birth the mares and foals were pastured in Field 6 on windless dry days, initially spending a few hours a day in the field. Finally after a few days they were left out day and night (Table 14). On 11 and 13 June, when the weather was cold and wet, all the animals were stabled for the night and turned out again the following morning. An exception to this was Polly's foal, Jemma, which cut herself on the fence within a few minutes of being released in the field for the first time on 10 May 1977. The cut had to be stitched and Polly and Jemma were not turned out again until 17 May 1977.

5:2:2:3 Routine recordings

The foals were weighed, radiographed and photographed, and their heights were measured on their first day of life. These recordings were subsequently made weekly.

Every third or fourth day after birth, until July, each mare was taken to a stallion and observed for signs of oestrous behaviour. The stallion was mated with the mare on alternate days while she was

TABLE 13 The daily food allowance, kg, of the mares A) in the stable B) in the field

	A			B	
	Hay	Oats	Bran	Oats	Bran
Polly	11	7	1.5	5	1
Gay	9	5	1	4	1
Kirsty	12	7	1.5	5	1
Emma	9	6	1.5	4	1
Flatspin	11	5	1	5	1

TABLE 14 The dates when the mares and foals were A) first turned out to grass B) pastured continuously

	A	B
Gay and Caliban	10.5.77	16.5.77
Kirsty and Captain Hook	10.5.77	16.5.77
Emma and Angel	10.5.77	16.5.77
Polly and Jemma	17.5.77	18.5.77
Flatspin and Bashful	28.6.77	29.6.77

in oestrus. Polly was mated on 1 and 3 June 1977; Emma was mated on 25 May, and 13 and 15 June 1977. Flatspin was in oestrus on 26 June 1977 but was not mated. Kirsty and Gay showed no oestrous behaviour.

5:2:3 Observation periods

All observation periods lasted for one hour. Seven observation periods, arranged to cover the time between 09.00 hr and 16.00 hr, were made on each mare-foal pair during weeks 1,2,3,4,6,8,12,16,20 and 24 after birth. These weeks will hereafter be referred to as Week 1, Week 2 and so on. This design was used since Tyler (1972) observed that changes in foals' behaviour occur rapidly during the first few weeks after birth and less often as the foals grow older.

Observation of foal behaviour began during the first 09.00 to 16.00 hr period after the foal's birth. When possible one observation period per day was made for each mare-foal pair, but observations were not made after a mare-foal pair had been out of the stable or field for any reason until the following 09.00 to 16.00 hr period

5:2:4 Behavioural recordings

5:2:4:1 Definition of activities

An ethogram was compiled which listed 12 mutually exclusive activities that foals perform. Ten of these were shown by mares. The activities are described in Tables 15 and 16. The two activities specific to foals were nursing and coprophagia.

TABLE 15 A definition of the twelve activities performed by foals

ACTIVITY	CODE	DESCRIPTION
1. Nursing	N	See Table 16
2. Coprophagia	C	See Table 16
3. General	G	See Table 16
4. Social	S	See Table 16
5. Eating hay	Eh	The animal bit, chewed and swallowed hay
6. Eating oats	Eo	The animal bit, chewed and swallowed oats and bran
7. Grazing	Gr	The animal bit, chewed and swallowed grass
8. Drinking	D	The animal drank from the water supply
9. Standing	St	The animal stood still without showing any other activity
10. Urinating	U	The animal stood, usually in the urinating posture, and urinated
11. Resting standing	Rs	The animal stood with its neck horizontal and with any of the following features: i) Eyes half closed or closed ii) Lower lip hanging iii) Ears deviated laterally iv) One hind leg bent
12. Resting lying	Rl	The animal was recumbent

TABLE 16 The behaviour patterns of nursing, coprophagia, general and social activities

ACTIVITY	BEHAVIOUR PATTERN	CODE	DESCRIPTION
1. Nursing	i) Nosing	Nn	The foal teat-sought in the pectoral or pelvic region
	ii) Sucking	Ns	The foal took hold of a teat and sucked
2. Coprophagia	i) Exploring	Ce	The foal approached, sniffed or pawed a pile of faeces
	ii) Biting	Cb	The foal bit into a stool
	iii) Chewing	Cc	The foal chewed a mouthful of faeces
3. General	i) Grooming	Gg	The animal groomed parts of its body with its mouth, leg or against a solid object
	ii) Moving	Gmo	The animal moved for four or more paces
	iii) Exploring	Ge	The animal nosed, sniffed, mouthed or licked objects
	iv) Playing	Gpl	The animal showed exaggerated motor activity patterns which occurred spontaneously and out of context
	v) Flehmen	Gf	The animal pointed its muzzle upwards with the upper lip curled back exposing the teeth
	vi) Pawing	Gpa	The animal pawed with one of its forefeet

TABLE 16 (cont.)

ACTIVITY	BEHAVIOUR PATTERN	CODE	DESCRIPTION
	vii) Oestrous	Go	The mare stood with her hindlegs apart and tail raised and held to one side. A small amount of urine was sometimes spilled
	viii) Marking	Gma	The animal excreted onto the excrement of another animal
4. Social	i) Watching	Sw	The animal stood looking at another animal
	ii) Approaching	Sap	The animal moved in a straight line towards, and to within 5 m of, another animal
	iii) Following	Sf	The animal followed another animal within 5 m of it
	iv) Threatening	St	The animal bit, kicked or threatened to bite or kick another animal
	v) Avoiding	Sav	The animal moved away or stepped aside submissively when approached, followed or threatened
	vi) Grooming	Sg	The animal groomed another animal
	vii) Exploring	Se	The animal sniffed, nosed or licked another animal
	viii) Grinning	Sg	The foal showed a grinning expression which was characterised by a sidewards or slightly backwards position of the ears and vertical movements of the lower jaw. During the movements the lips never met, the teeth were covered by the lips and the corners of the mouth were drawn back
	ix) Playing	Sp	Two or more animals played together

5:2:4:2 Definition of behaviour patterns

Nursing, coprophagia, general and social activities were divided into their component behaviour patterns (Table 16). Oestrous behaviour was only shown by the mares while play and grinning behaviour were shown only by the foals.

5:2:4:3 Nursing activity

It was only possible to distinguish between nosing and sucking behaviour by foals when observations were made in the stable or when the mare and foal were within 10 m of the observer.

In addition to recording behaviour patterns, during nursing activity the following data were noted:

1. The side of the mare from which the foal nursed.
2. The time spent sucking each teat.
3. Which of the pair ended the sucking.
4. The frequency with which the foal thrust its muzzle into the udder, i.e. 'pushed'.
5. The frequency of 'resistances' shown by the mare (Table 17).
6. The length of time that the mare flexed the hind leg on the side opposite to the foal.
7. Instances when the foal nosed in the pectoral region.

A nursing activity was not allocated to the mares which usually stood still, ate or rested standing while the foals nursed.

5:2:4:4 Recording methods

Recordings were made with the aid of a clockwork stopwatch, cassette

TABLE 17 The 'resistances' shown by mares during nursing activity

'Resistance'	Description
Avoiding	The mare moved away from the foal
Lifting leg	The mare lifted her hind leg on the side from which the foal nursed
Kicking	The mare kicked
Biting	The mare bit
Lashing tail	The mare lashed with her tail
Pawing	The mare pawed the ground vigorously

recorder and a pair of 8 x 30 binoculars (field use only). During an observation period a continuous recording was made of the activities of a mare-foal pair by noting the time when each activity, shown by both the mare and the foal, began. The time taken for the observer to record an activity meant that activities had to be maintained for 2 sec or more before they could be recorded. If nursing, coprophagia, general or social activities occurred then the relevant behaviour patterns were recorded in the same way and in addition to the activity.

5:2:4:5 Miscellaneous

At times, when the mare and foal under observation were grazing or resting in the field, it was possible to record data from the other animals in addition to the continuous recordings. Some social activity and some incidents of coprophagia were recorded in this way. (Where these recordings have been included in the data they have been described as adventitious recordings).

Since horses often defaecate while they eat, defaecation was not classed as an activity, but the occurrence of defaecation during observation periods was recorded.

5:2:5 Statistical analysis

During the work described in Section 4 it was noticed that foals made frequent short pauses in nursing activity. It was hoped that a nursing bout could be defined by dividing these pauses - intervals - into either inter- or intra-nursing bout intervals according to their duration. The duration of every interval in nursing activity

recorded from each foal in Week 1 was measured. If nursing activity occurred at random intervals then the frequency distribution of the intervals should conform to a negative exponential distribution. Under this hypothesis the natural logarithm of the cumulative frequency of any given interval, summed from the upper end of the distribution, should be proportional to the length of that interval. Therefore the $\log_e$ of the cumulative frequency plotted against the interval length should give a straight line with negative slope.

Any deviations in the gradient would suggest a more complex model which could be the result of the superimposition of two distributions; in this case the inter- and intra-nursing bout interval distributions.

A paired 'Student's t-test' (Bailey, 1975) was used to determine the significance of differences in:

i) the duration of nursing at different times of the day during each of the Weeks 1, 6, 8, 12, 16, 20 and 24,

ii) 'Interval' time, expressed as a percentage of nursing time, between each pair of Weeks 1 to 24 inclusive,

iii) the mean nursing time per hour, the mean frequency of nursing bouts per hour and the mean nursing bout duration between each pair of the Weeks 1 to 24 inclusive,

iv) the number of nursing bouts made from the right and the left side of the mares,

v) the mean frequency of mare-to-foal or foal-to-mare interactions between each pair of the Weeks 1 to 24 inclusive.

Analysis of variance (Bailey, 1975) was used to determine the

significance of differences in:

i) the mean length of successful nursing bouts recorded from five foals during Week 1,

ii) the mean length of unsuccessful nursing bouts recorded from five foals during Week 1,

iii) the mean length of all nursing bouts recorded from five foals during Weeks 6, 8, 12, 16, 20 and 24.

Analysis of variance and a paired 'Student's t-test' were used to test for the significance of differences in the time that each one of five foals spent sucking the right teat and the left teat while nursing.

The mean frequency with which a mare or foal changed its activity per hour was estimated from the following formula:

$$\frac{\text{the number of activities recorded from a mare or foal}}{\text{the number of hours that the mare or foal was observed}}$$

The mean frequency with which a mare or foal changed its activity per hour was estimated for each of the Weeks 1 to 24 post-partum inclusive, and for Days 1 to 7 post-partum inclusive.

5:2:6 Observations after weaning

Jemma, Caliban, Captain Hook and Angel were weaned on 10 November 1977. The four mare-foal pairs were walked past the door to the stalls and each foal was led into the stalls while the mare was taken back to the stable yard. A gate had been fixed across the end of each stall forming five small loose boxes, each one 2.8 m x 1.8 m. Observations began as soon as each foal was

secured in a loose box, and were made for four consecutive hours, from 10.45 hr to 14.45 hr on the first three days after weaning. During this time the activity of each foal was noted at one minute intervals and the occurrence of all vocalisations was recorded.

5:3 Results

5:3:1 The activity of the mares and foals

5:3:1:1 The time spent feeding, resting and in all the 'other' activities

The time spent by a mare and foal feeding, resting and in the 'other activities' was expressed as a percentage of the observation time (7 hr in all cases except for Gay, Kirsty and Emma in Week 2 when different estimates were made for stable and field observations). The means of these values are shown in Figure 6.

5:3:1:1:1 Mares

During Week 1 a mare spent 47% of the observation time in 'other activities' and in particular standing alert (38%). Forty-five percent of the time was spent feeding while resting occurred during 8% of the observation period. After Week 1 the mares always spent more than 50% of the observation period feeding and the time spent in 'other activities' decreased correspondingly. Resting time increased in Week 4 and thereafter comprised the second largest part of the observation period.

5:3:1:1:2 Foals

During the first week post-partum the foals spent more time in activity than resting. Each foal lay down to rest with a mean frequency of once per hour and stood resting eight times an hour.

These rest periods alternated with periods of lively activity when the foal changed its behaviour pattern very rapidly in a sequence such as: exploring, playing, nursing, exploring, grooming ... etc. Many of these behaviour patterns were maintained for only a few seconds at a time. All the objects in the environment such as the walls, hay, water bucket and the observer were sniffed, licked and mouthed by the foals during their first few days of life.

During Week 1 the foals spent 40 per cent of the observation period resting and 40 per cent in 'other activities'. General activities and standing alert were the most common 'other activities'. Almost all of the feeding time in Week 1 was spent nursing.

While in the field, during Week 2, the foals rested for 26 per cent and showed 'other activities' for 57 per cent of the observation time. In the stable this situation was reversed. During Week 2 feeding activity accounted for 17 per cent of the time in either the stable or the field. During Weeks 3 to 16 inclusive the foals rested for most of the observation period. Their feeding time increased as they grew older and the time spent in 'other activities' decreased. By the time the foals were 20 and 24 weeks old they spent the most time feeding and the least time in 'other activities'.

The foals' nursing time decreased as they grew older. During Week 1 nursing activity comprised 98 per cent of the foals' feeding time recorded during the 7 hr observation period. However by Week 24 this value had dropped to 4 per cent of the foal's feeding

time.

5:3:1:2 Changes in the activity of the mares and foals

5:3:1:2:1 Mares

On the first day after foaling the mares were particularly restless and a mean of 94 changes in activity per hour was recorded (Figure 7). However this declined so that during Week 1 each mare was changing her activity with a mean frequency of 63 changes per hour (Figure 8), each activity having a mean duration of 1 min. Most of these activities were standing alert (22/hr), social activity with her foal (14/hr) and eating hay (13/hr). During Week 2 the mares' activity rate dropped to 38 changes in activity per hour while stabled but in the field this value rose to 72 changes per hour. Most of the activities shown by a mare in the field were grazing, 'general activities' and 'standing alert'. As the time post-partum increased the mares changed their activity less often and by Week 4 the mares were changing activity 35 times per hour while in Week 24 this value was reduced to 25 times per hour.

5:3:1:2:2 Foals

The mean frequency with which foals changed their activity tended to decrease towards the end of Week 1 although the changes in this frequency were erratic. They changed their activities less often in the stable and more often in the field than the mares. During Week 1 each foal showed 59 changes in activity per hour. Most of these were 'standing alert' (18/hr) and 'general activities' (17/hr). In Week 2, while stabled, foals showed 32 changes in activity per hour but when the foals were pastured this figure rose

to 91 changes per hour. In the field the most commonly occurring activities were 'standing alert' (31/hr) 'social activity' with dam (22/hr) and 'general activity' (20/hr). At the age of 4 weeks foals were changing their activity 50 times per hour and by 24 weeks this value had dropped to 30 changes per hour. As the foals grew older they grazed more and interacted with their dams less than previously. From Week 6 onwards grazing activity occurred more often than social activity with dam.

5:3:1:3 General activities

The behaviour patterns, included as general activities, that were recorded most often from the mares and foals were moving, grooming and exploring. During Week 1 foals explored with a mean frequency of 17 times per hour, moved 11 times, groomed 5 times, played 5 times and pawed the ground once per hour. These frequencies decreased steadily as the foals grew older and by 24 weeks of age every foal moved with a mean frequency of four times per hour, groomed once and explored once per hour.

5:3:1:3:1 Play behaviour

The foals started to play when they were two days old. They cantered with shaky steps, stopped suddenly, tried to buck and sometimes ran backwards. During Weeks 2 and 3, in the field, they usually played alone within a 20 m radius of their dams, galloping in circles or in a line to and from their dams. Their tails were usually raised and they would sometimes buck or quickly mount their dams while playing. Falling over while playing was frequent and when they stood up they ran to their dams and stayed close to them for

a few minutes. Solitary play occurred most often during Weeks 2 and 3 (Table 18). Captain Hook spent little time playing in the stable but played more than the other foals in the field. Mutual play started at the age of six weeks and involved more complex patterns of behaviour and was recorded until the foals were weaned (see 5:3:3:4:1).

5:3:2 Feeding activities

These included nursing, grazing and eating hay and oats.

5:3:2:1 Nursing activity (Plate 2)

Foals initiated all nursing activity by approaching their dams and nosing. This was a teat-seeking behaviour pattern directed towards the udder. However during Week 1 the foals occasionally nosed between their dams' forelegs. A foal usually nosed by moving its muzzle from side to side across the udder or by pushing its muzzle between the mares' hindlegs then drawing it back over the teats. As soon as it grasped a teat the foal started to suck. During the first day after birth foals sucked the mares' tails, the insides of their hind legs and the sides of the udders while nursing. When nursing they usually stood alongside the mares, facing in the opposite direction. However some foals also nursed from behind the mares, facing in the same direction as them, with their heads bent round the mares' hindlegs. All variations between these two positions were seen. Nursing commonly occurred after resting or after a disturbance which caused foals to approach their dams.

TABLE 18 The time (sec) spent in solitary play per hour recorded during seven hours of observation on each of five foals in the post-partum weeks shown

Weeks post-partum	Jemma	Caliban	Captain Hook	Angel	Bashful	Mean
1	46	24	0	43	11	25
2 (stable)	11	24	2	8	-	11
2 (field)	-	55	201	180	42	120
3	19 (stable)	64	62	71	0	49 (field)
4	11 (stable)	6	0	1	1	2 (field)
6	0	0	0	7	0	0
8	2	3	4	0	0	2
12	0	0	0	0	0	0
16	0	1	0	9	0	2
20	0	0	10	0	10	4
24	0	3	0	0	5	1

5:3:2:1:1 Definition of a nursing bout

The statistical method described in Section 5:2:5 was used to define a nursing bout. Two stages were apparent in the negative exponential line derived from the intervals in nursing activity (Figure 9). The first stage was composed of intervals shorter than 27 sec. Intervals of 27 sec or longer formed the second stage. This showed that shorter intervals, lasting for less than 27 sec, occurred more frequently than the longer intervals, indicating that periods of nursing activity occurred grouped together in bouts, the two parts of the negative exponential line being composed of short intra-bout intervals and longer inter-bout intervals. Thus for the purpose of this study a nursing bout was defined as: "A period of nursing activity delimited by intervals of non-nursing activity lasting for 27 sec or longer".

5:3:2:1:2 Nursing bouts

Since, by virtue of the definition of a nursing bout, intervals of non-nursing activity lasting less than 27 sec could occur within a nursing bout in addition to nosing and sucking behaviour. The behaviour recorded during these intervals will hereafter be referred to as 'interval behaviour'.

Nosing behaviour always occurred during a nursing bout. Occasionally it occurred alone but more often one or both of the other behaviour patterns were also recorded. Sucking behaviour could only be distinguished from nosing behaviour when the animals were stabled. Since the foals did not always suck during a nursing bout all the bouts recorded in the stables were divided into either successful

bouts, when the foal sucked, or unsuccessful bouts, when the foal nosed but did not suck. Therefore as the foals were pastured at different ages between Weeks 2 and 5 only data from Week 1 was used for the analysis of successful and unsuccessful nursing bouts.

Differences between the foals in the mean duration of either successful or unsuccessful nursing bouts were not significant. Similarly there was no significant difference between foals in the mean duration of all nursing bouts recorded during Weeks 6 to 24 inclusive.

Two frequency distributions with nursing bout frequency plotted against nursing bout duration were drawn. The first histogram used data recorded from five foals in Week 1 and the second used data recorded from five foals during Weeks 6 to 24 inclusive (Figure 10). The frequency histogram shown in Figure 10A has two parts which are distributed along different parts of the X axis. One part is composed of the short, unsuccessful nursing bouts and the other is made up of the longer, successful bouts. The distributions shown in Figure 10B are similar to those in Figure 10A although it was not known which, if any, of these bouts were successful or unsuccessful. During Weeks 6 to 24 there were fewer short bouts than during Week 1. Also the distribution to the right of the X axis in Figure 10B had a smaller spread and a lower mean ($\bar{x}$ = 84 $\pm$ 1 sec) than that shown in Figure 10A ($\bar{x}$ = 138 $\pm$ 3 sec).

5:3:2:1:3 The time spent in nursing activity

The only significant difference in hourly nursing duration between different hours of the day, in Week 1, was between 09.00 hr and 15.00 hr. Nursing duration recorded at 15.00 hr was less than that recorded at 09.00 hr ($p \leqslant 0.01$). Significant differences in hourly nursing duration between different hours of the day in Weeks 6 to 24 were as follows: in Week 12 nursing duration was less at 10.00 hr than at 12.00 hr ($p \leqslant 0.05$) in Week 20 nursing duration at 15.00 hr was less than at 10.00 hr ($p \leqslant 0.05$) and in Week 24 nursing duration was less at 12.00 hr than at 11.00 hr ($p \leqslant 0.05$).

The mean nursing duration per hour decreased as the foals grew older (Figure 11A). They nursed significantly more in Week 1 than during any other week ($p \leqslant 0.01$) and significantly less in Week 24 than during any other week except Weeks 16 and 20 ($p \leqslant 0.05$). The rapid change in nursing duration between Weeks 1 and 4 was due to a decrease in both the frequency of nursing bouts and nursing bout duration (Figure 11B and C). Nursing bout duration was significantly greater in Week 1 than at any other time ($p \leqslant 0.01$). In Week 24 nursing bout frequency was significantly less than in Weeks 1, 2, 3, 4, 6 and 8 ($p \leqslant 0.05$). Nursing bout duration was only significantly greater in Week 1 compared with Weeks 3, 4 and 24. Other differences in nursing bout duration were not significant.

In Week 1 each foal had an average of seven nursing bouts per hour with a mean bout duration of 105 sec. By Week 24 these values had decreased to one bout per hour with a mean duration

of 74 sec.

5:3:2:1:4 The frequency, duration and composition of nursing bouts recorded during Weeks 1 and 2

During Week 1 each foal made an average of five successful nursing bouts and two unsuccessful bouts per hour. The mean duration of the successful bouts was 140 sec and of unsuccessful bouts was 17 sec. By Week 2, in the stable, the bout frequencies had decreased to three successful bouts and one unsuccessful bout per hour; the bouts having a mean duration of 131 sec and 17 sec respectively. The composition of the bouts was similar each week. Successful nursing bout duration was comprised of sucking behaviour, 60 per cent, nosing behaviour, 30 per cent and 'interval behaviour', 10 per cent. In Week 2, while the horses were pastured, a mean frequency of four nursing bouts per hour, with a mean duration of 83 sec was recorded from each foal (Table 19).

5:3:2:1:5 The proportion of nursing time spent in 'interval behaviour'

Differences in the percentage of nursing duration comprised by the duration of 'interval behaviour' between field and stable recordings in Week 2 were not significant. However the proportion of nursing time spent in 'interval behaviour' was significantly less in Weeks 4 to 20 than in Weeks 1 to 3 ($p \leqslant 0.01$, Figure 12).

5:3:2:1:6 Sucking behaviour

A continuous period of sucking behaviour was called a 'burst'. During a successful nursing bout the foal sucked the teats in a

TABLE 19 The mean frequency, duration and composition of nursing bouts recorded during Weeks 1 and 2

	Bout frequency per hour	Mean bout duration, sec	Duration of sucking, sec	Duration of nosing, sec	Duration of 'interval behaviour', sec
Week 1					
Successful bouts	5	140 ± 3	84 ± 3	44 ± 2	12 ± 1
Unsuccessful bouts	2	17 ± 2	-	14 ± 2	3 ± 1
Week 2 (Stable)					
Successful bouts	3	131 ± 7	78 ± 4	39 ± 3	14 ± 2
Unsuccessful bouts	1	17 ± 5	-	16 ± 4	1 ± 1
Week 2 (Field)	4	83 ± 6	75 ± 2		8 ± 5

series of 'bursts' usually changing teats on alternate 'bursts' but occasionally sucking from the same teat for up to six successive 'bursts'.

A mean of nine 'bursts' per successful bout was recorded during Week 1 (Table 20), no significant difference between the mean 'burst' duration on the right and the left teat being recorded from each foal. Also there was no significant difference between the mean sucking duration on the right and left teat during a successful nursing bout. The side of the mare from which the foal nursed had little effect on the foal's teat preference; the percentage of sucking time on the left teat was 48 per cent when the foal nursed from the left side and 53 per cent when it nursed from the right side of its dam.

5:3:2:1:7 Side of dam from which the foal nursed

There was no significant difference in the number of nursing bouts made from the right or the left side of the mare. The only difference, which occurred when the horses were stabled, was that more successful nursing bouts were made from the right side of the mare than the left side ($p \leqslant 0.05$).

5:3:2:1:8 Interactions within a mare-foal pair during nursing activity

During the first week after birth the foals nosed in both the pectoral and pelvic regions of their dams. Initially the mares helped their foals by standing still, by stepping forward to bring the udder to the foal's head and by flexing the hind leg on the

TABLE 20 The mean duration of sucking 'bursts' (sec) on the right and left teats and the mean frequency of 'bursts' per successful nursing bout recorded from five foals during Week 1

	Jemma	Caliban	Captain Hook	Angel	Bashful	Mean
Mean 'burst' duration) Right teat	12	9	10	8	9	10
) Left teat	12	9	9	8	9	9
Mean 'burst' frequency per bout	8	7	9	11	10	9

side away from the foal to angle the teats towards the foal's mouth. When the foal found the udder and took hold of a teat it pushed its nose firmly into the udder before and during sucking. At times the mares showed signs of discomfort to these 'pushes' and actively tried to stop the foals from nursing. There were six ways in which the mares 'resisted' the foals' nursing activities (Table 17). Most 'resistance' was shown during the nosing phase of a nursing bout and at times the foals had to be very persistent to achieve sucking. The frequency of 'pushes' was greatest in Week 2 while the mares 'resisted' nursing the most often in Weeks 2 and 3 (Figure 13). The effect that this had on successful nursing activity is shown by the data on Jemma who was stabled during Weeks 1 to 4 (Figure 14). In Week 3 the proportion of nursing duration spent sucking decreased and there was a corresponding increase in the proportions of nosing and 'interval behaviour'. During Week 2 the mares were more likely to end nursing bouts than at any other time (Figure 15).

When a foal approached its dam to nurse it often walked along one side of her, pushed under her neck and walked down the other side to the udder. This encouraged the mare to stand if she was walking or eating. When a mare avoided her foal's attempts to nurse the foal repeated this pattern to make her stand still. The foals also pawed the ground, cantered in a circle or reversed into the mare and kicked her if frustrated in their efforts to suck. Sometimes, when a mare was lying down and her foal tried to nurse, the foal pawed the ground or the belly of the mare until the mare stood up.

The mares' co-operation with their foals during nursing activity was also measured by the percentage of nursing duration that the mare stood still and flexed her opposite hind-leg (Figure 16). There was a drop in the time spent in both these behaviour patterns from Week 1 to Week 2 with a steady increase after Week 2.

The mares rarely licked the foals. Occasionally mares sniffed and licked their foals while the foals nursed but vigorous licking by the mare was not seen.

5:3:2:2 Eating hay and oats

From the first day after birth all the foals explored hay by nosing, pawing, mouthing and licking it. The foals took mouthfuls of hay. At first they were unable to bite, chew or swallow it and would drop the hay after trying to chew for a few minutes. However the ability to chew improved towards the end of Week 1 and by this time the hay that they dropped had been well chewed. When the foals started to eat hay their rate of biting and chewing was more regular than previously and they did not drop mouthfuls of chewed hay. Captain Hook was observed to eat hay for the first time on the fifth day, Caliban on the sixth day and Jemma on the eighth day after birth. Angel and Bashful were not observed to eat hay before they were pastured all day. Eventually when the foals ate hay they pawed and nosed it and pushed it around with their muzzles between taking mouthfuls. The foals showed little interest in the cornfeed and did not explore it although each foal often stood alongside its dam while she was feeding. Only Jemma from 17 days and Caliban from 11 days after

birth were observed to eat oats. The time that each mare spent eating hay during the seven observation hours in Week 1 ranged between 143 min and 198 min; the incidents having a mean duration of 110 sec. The duration of eating oats varied from 6 min to 30 min between the mares with the incidents having a mean duration of 70 sec. Flatspin and Bashful were fed hay in Week 24. During the seven hours of observation 24 incidents of eating hay were recorded from both the mare and the foal with a mean duration of 5 min 10 sec from Flatspin and 5 min 20 sec from Bashful.

5:3:2:3 Grazing behaviour

All the foals started to graze within half an hour of being released in the field. The foals had to splay their legs to reach the grass until they were between 8 and 10 weeks old and in particular during Weeks 2 and 3 they were also observed kneeling while they grazed. They often grazed places where the grass was longer or the ground was sloping and they would graze together in a line along the fence while the mares were some distance away.

At first the foals nibbled grass for periods of 3 to 15 sec and straightened their legs after biting the grass. The mean duration of grazing by foals, during the 7 hr of observation, increased from 70 min in Week 3 to 171 min in Week 24 (Figure 17). The increase from Week 3 to Week 24 was significant ($p \leqslant 0.05$) likewise the increase from Week 16 to Week 20 was also significant ($p \leqslant 0.01$). Changes in the mares' grazing time were not significant. Grazing times for Flatspin and Bashful have been excluded from the calculation for Week 24 when they were fed hay.

From Week 2 onwards all the foals were observed to lick the soil occasionally.

5:3:3 Social interactions

On the first day after foaling the mares were alert to every sound and movement in their environment. Each mare kept her foal in view all the time and tended to keep herself between the foal and the stable door. If other horses were led round the stable yard then the mares became agitated and threatened them over the stable door. Some mares also threatened dogs, sparrows and humans, including the observer, at this time.

5:3:3:1 Interactions within a mare-foal pair

During the first week post-partum the mares approached, watched, explored and followed their foals more often than in any subsequent week. The mean number of these mare-to-foal interactions recorded during 7 hr of observation in Week 1 was 111 interactions. However individual values in Week 1 varied from 38 interactions, recorded from Kirsty, to 245 interactions, recorded from Gay. The frequency of mare-to-foal interactions per hour during the foals' first seven days decreased with an increase in age of the foal with the largest change occurring between Days 1 and 2 (Figure 19). The mean number of mare-to-foal interactions in Week 2 had decreased to 32 while stabled and when the animals were pastured mare-to-foal interactions rarely occurred (Figure 18). Conversely the foals approached, watched, explored and followed their dams more often in the field than in the stable. During Week 2, when pastured, a mean of 190 foal-to-mare interactions

were recorded from every foal in seven hours of observation compared with 32 interactions while stabled. Individual values varied between 343 interactions recorded from Caliban and 98 from Captain Hook while pastured. As the foals grew older the number of foal-to-mare interactions decreased (Figure 18). There were large individual differences in the number of interactions recorded and although mares and their foals tended to interact less as the foals aged the variability between individuals was so large that a comparison of weekly data was non-significant.

Most of the mare-to-foal interactions recorded in both the stable and the field were exploratory. Foal-to-mare interactions in the stable were mostly exploratory but in the field the foals followed and approached their dams more than they explored them (Table 21). Foals also maintained proximity with their dams by grazing with them or, if the foal was resting standing, it sometimes crept forward as the dams grazed. In these cases an interaction was not recorded. In the stable 64 per cent of all interactions within a mare-foal pair were made by the dam but in the field this value was only 5 per cent. Often mares nickered when they interacted with their foals and when they were eating hay. This was not an exclusive behaviour pattern and it could not always be recorded when the animals were in the field.

Mares were rarely aggressive towards their own foals apart from the threats given during nursing activity (Section 5:3:2:1:8), only 33 mare-to-foal threats were recorded during all the observation periods, 19 of which were Kirsty threatening Captain

TABLE 21 The total number of mare-to-foal and foal-to-mare interactions recorded in the stable and in the field

		Approach	Watch	Explore	Follow
Stable	mare-to-foal	60	116	458	0
	foal-to-mare	129	1	231	71
Field	mare-to-foal	23	11	85	26
	foal-to-mare	623	1	588	1282

Hook. The foals submitted to nine threats, grinned to three and ignored 21. Foals were not seen to threaten their dams.

Mares and their foals started to groom mutually from three weeks after birth. Twenty-seven incidents were observed of which 24 were started and six ended by the foals, the mean duration of these being 52 sec with a range of 4 to 244 sec.

Foals lost their dams on five occasions, each incident occurring after the foal had been lying down. On standing up again the foal seemed to have difficulty identifying its dam and it approached other mares several times before finding its mother. The other mares threatened the lost foal when it approached them and the foal finally approached its dam slowly and spent several seconds sniffing her or grinning at her before nursing or grazing. When lost the foals cantered in circles whinnying, approaching or following other mares and foals and sometimes even approaching their dams to within 10 m before turning away again. The mother of a lost foal showed no reaction to the foal's calls until, in three cases the mother approached or called to her foal and the pair were then reunited within 20 sec (Table 22).

Only the two male foals were observed mounting their dams. This occurred during play behaviour when Caliban and Captain Hook were each 3 weeks old.

5:3:3:2 The time spent in social interactions excluding that spent in interactions within mare-foal pairs

During Week 2, when the horses were pastured, each mare tended to

TABLE 22 Instances when foals lost their dams

Foal	Age (weeks)	Time taken to find dam	No. of approaches to other mares	No. of threats from other mares	Dam's help to foal
Caliban	4	4 min 06 sec	5	0	Approach
Angel	4	3 min 55 sec	7	1	Whinny
Angel	4	6 min 10 sec	5	6	None
Angel	4	5 min 55 sec	7	0	None
Bashful	4	1 min 21 sec	2	1	Approach

keep apart from the other mares, her foal staying within 5m of her. Only one social interaction per 2 hr was recorded from each animal. However, by Week 3 this value increased fourfold. In Week 2 each foal spent a mean of 13 sec an hour interacting with other mares or foals and this figure increased to 1 min 12 sec in Week 3 and to 2 min 21 sec by Week 24, with a drop to 51 sec per hour in Week 20. Between 12 sec and 40 sec an hour was spent by the mares in interactions with other mares and foals (Figure 20). However data from Flatspin and Bashful have been omitted from these values for Week 24 because the other four foals had been weaned by this stage.

5:3:3:3 Interactions between pairs of mares

The dominance-subordination relationships within the group of mares was estimated from the number of threats, approaches and submissions recorded during the observation periods and including adventitious observations (Table 23). The observed hierarchy was linear with one temporary unsettled relationship between Kirsty and Gay. During Weeks 2 and 3, while pastured, Kirsty threatened both Gay and Emma and also received threats from them but only Gay submitted to her. After two weeks, when Gay started to ignore her, Kirsty stopped making the threats (Figure 21).

The number of threats and approaches and submissions recorded from each mare were directly related to her position in the hierarchy. Of all the mares Polly made the most threats and Kirsty made none while the reverse was true for submissions (Table 24). It was also observed that Polly, the most dominant mare, often approached

TABLE 23 The number of threats, approaches and submissions recorded from Mare 1 towards Mare 2 during all of the observation periods and including adventitious observations

Mare 1	Polly				Emma				Gay				Flatspin				Kirsty			
Mare 2	E	G	F	K	P	G	F	K	P	E	F	K	P	E	G	K	P	E	G	F
Threats	74	89	41	38	0	80	26	24	0	0	57	34	0	0	2	22	0	11	41	0
Approaches	27	39	13	16	0	14	15	7	0	0	25	18	0	0	0	12	0	2	2	0
Submissions	0	0	0	0	97	0	0	0	126	90	0	31	53	41	82	0	53	31	46	34

P = Polly

E = Emma

G = Gay

F = Flatspin

K = Kirsty

TABLE 24 The number of mare-to-mare threats and approaches and submissions recorded from each mare in Weeks 6 to 20 inclusive

	Polly	Emma	Gay	Flatspin	Kirsty
Threats and approaches	80	47	40	16	0
Submissions	0	28	48	52	55

and threatened other mares in situations which did not usually elicit threats. If walking across the field Polly would change direction in order to threaten a subordinate horse and if she was the first to waken from a rest period she threatened the other mares and foals until they were awake and started to graze. On one occasion Polly stopped grazing and walked to a corner of the field to rest. After a few minutes she walked back to the other mares which were grazing and drove them to the corner of the field where she started to rest again while the other animals continued grazing. Finally, after resting a few minutes, she then started to graze with them. Similar behaviour patterns were not seen in the other mares.

During two observation periods, on 10th and 13th August 1977, Flatspin repeatedly approached and threatened Kirsty and followed her around the field. This lasted for a total of 10 min 27 sec on 10th August and 22 min 30 sec on 13th August. When Flatspin stopped to graze Kirsty also grazed until Flatspin approached her again. Captain Hook and Bashful followed their dams and the four animals formed a line walking in circles for up to 6 min at a time. Flatspin retaliated to a single threat from Kirsty and ignored three threats from Captain Hook. All the interactions involved in Flatspin driving Kirsty have been excluded from Tables 23 and 24 and from Figure 20 since this was considered to be an unusual situation. Furthermore Flatspin was also seen driving Kirsty on 13th August 1977 outwith a normal observation period.

Only two incidents of mutual grooming between mares were observed.

Both incidents were initiated by Gay. One with Flatspin lasted for 27 sec and one with Kirsty for 50 sec, and both were ended by the groomed mare.

5:3:3:4 Interactions between pairs of foals and between mares and foals other than mare-foal pairs

Each foal showed curiosity towards the other horses and up to the age of 4 weeks foals approached, watched, explored and followed other mares and foals. Other mares usually responded to these interactions with a threat while other foals responded either by moving away from the foal and towards their own dam or by mutually watching and exploring. During Weeks 3 and 4 a series of approach-watch-explore interactions between two foals usually ended with both foals jumping away from each other and running to their dams. Some mares threatened inquisitive foals if they approached their own foals.

5:3:3:4:1 Mutual play

After Week 4 the foals started to play together. Before this age the foals played alone, moving in circles round their dams; being watched by other foals. Mutual play consisted of two or more foals cantering together with one foal chasing the other, both stopping and turning to face eachother, shaking their heads and necks, bucking, rearing and biting or kicking each other. This was usually initiated when one foal cantered towards or around

another foal which then started to play as well.

Fifty-four incidents of mutual play or 'games' were observed during the observation periods. The youngest foal seen playing mutually was Caliban, aged 4 weeks, playing with Jemma, aged 6 weeks. 'Games' were between 6 sec and 392 sec in duration. The two colt foals, Captain Hook and Caliban, played together most often, having the longest 'games' and spending the most time playing. Eighty minutes of mutual play by Captain Hook and 51 min by Caliban were recorded compared with 31 min and 18 min from Jemma and Angel respectively. Bashful, at least 6 weeks younger than the other foals, only played mutually once (Table 25).

5:3:3:4:2 Mutual grooming

From 6 weeks of age foals groomed mutually. Forty-four incidents of foal-to-foal mutual grooming were observed (Table 26). These had a mean duration of 60 sec with a range from 5 sec to 433 sec and in 24% of cases the foal that initiated grooming also ended it. Foals were seen to groom their dams but no other mares.

5:3:3:4:3 Dominance-subordination relationships

The foals submitted and grinned to mares and other foals from their first hours in the field at 2 weeks old but did not show a facial threat expression until they were 6 to 8 weeks old. Only 81 foal-to-foal threats

TABLE 25 The number and mean duration (sec) of 'games' recorded from the foal pairs shown

Foal pair	No. of 'games'	Mean duration of 'games'
Jemma and Caliban	3	25 sec
Jemma and Captain Hook	14	115 sec
Jemma and Angel	5	31 sec
Caliban and Angel	5	56 sec
Caliban and Captain Hook	15	182 sec
Captain Hook and Angel	11	44 sec
Angel and Bashful	1	138 sec

TABLE 26 The number of incidents of mutual grooming recorded from the foal pairs shown

Foal pairs	Number of incidents
Jemma and Caliban	10
Jemma and Captain Hook	1
Jemma and Angel	17
Caliban and Angel	7
Caliban and Bashful	3
Captain Hook and Angel	1
Captain Hook and Bashful	4
Angel and Bashful	1

were recorded during all of the observation periods compared with 539 mare-to-mare threats during the same period. There was no consistent dominance hierarchy between the foals which could be related to the hierarchy between the mares. However, Jemma, Captain Hook and Angel were considered to be at the top of the hierarchy with Caliban and Bashful at the bottom (Table 27).

Grinning behaviour was shown by the foals as a submissive gesture to adults from their first hours in the field at two weeks old until they were weaned. They grinned when approached or threatened by an adult other than their own dam or when the foal approached an adult and stood within a few metres of her. A total of 77 occasions when foals grinned at mares were recorded, including adventitious recordings, 55 of which involved Captain Hook. Up to 6 weeks of age the foals sometimes grinned when approached and explored by another foal. Twenty-three such cases were recorded, including adventitious recordings, 15 of which involved Caliban grinning at Captain Hook. However foals rarely grinned at their dams.

Most of the mare-to-other-foals interactions were threats. Three hundred and seventy three mare-to-foal threats, 82 approaches, 19 explores, five follows and two watches were recorded, including adventitious recordings. The foals submitted to some of these interactions and ignored

TABLE 27 The number of interactions that Foal 1 made to Foal 2 recorded during all the observation periods and including adventitious recordings

Foal 1	Jemma				Caliban				Captain Hook			
Foal 2	C.	C.H.	A.	B.	J.	C.H.	A.	B.	J.	C.	A.	B.
Threats	7	4	5	1	1	1	1	0	3	15	2	4
Approaches	23	3	32	2	16	14	23	7	11	57	24	39
Submits	12	5	18	5	12	3	24	0	5	2	15	0

Foal 1	Angel				Bashful			
Foal 2	J.	C.	C.H.	B.	J.	C.	C.H.	A.
Threats	0	10	9	8	0	0	0	0
Approaches	8	28	14	8	5	4	4	2
Submits	18	10	6	0	5	8	49	14

J. = Jemma
C. = Caliban
C.H. = Captain Hook
A. = Angel
B. = Bashful

some. The number of mare-to-other-foal threats that were ignored by the foals decreased as the foals grew older. During Weeks 2 and 3 the foals ignored 20% of the adult threats and approaches but by Week 8 this value had decreased to 8% (Table 28). When the foals did submit to adults they often ran to their dams immediately afterwards. During Weeks 2 and 3 this occurred after 88% of the submissions but by Week 8 this behaviour pattern had almost disappeared (Table 28). The foals were submissive to all the mares and never threatened them except for three threats made by Captain Hook to Flatspin (Section 5:3:3:3).

5:3:3:4:4 Reactions of foals to oestrous behaviour in mares

On 16th September 1977, when Flatspin was showing oestrous behaviour, Captain Hook approached her several times, groomed her, chewed her head collar and sniffed her perineum and flank. He showed flehmen after sniffing her and once marked her urine with his own (Section 5:3:4:2). Flatspin responded by sniffing Captain Hook's head and standing in the oestrous posture. During one hour of observation Captain Hook and Flatspin interacted in this way for 12 minutes. Also on 8th October 1977 Flatspin approached Captain Hook and stood in the oestrous posture, Captain Hook grinned for a few seconds and then sniffed Flatspin's flank for 1 minute.

TABLE 28 The response of foals to mare-to-other foal threats and approaches recorded during all the observation periods and including adventitious recordings

Age of foal	% m-t-o-f threats and approaches ignored by foal	% foals' submissions to adults when foal approached dam
2 - 3 weeks	20%	88%
4 - 7 weeks	12%	32%
8 - 24 weeks	7%	1%

On 22nd May Gay showed oestrous behaviour. She stood in the oestrous posture while Caliban nursed and she showed flehmen and made the oestrous posture after sniffing her own urine. Gay also explored the ground and then showed flehmen on 20th May and Caliban showed flehmen after sniffing Gay's perineum on 24th May. However Gay's oestrous behaviour did not elicit any reactions from the other mares and foals.

Emma and Polly, on 19th June and 27th September respectively stopped grazing and performed flehmen while standing in the oestrous posture. Emma also showed flehmen on 16th May, 19th June, 23rd June and 2nd August immediately before or after urinating or defaecating but without showing the oestrous posture (Plate 3).

5:3:3:5 Interactions with other species

At times during the experiment there were cattle and sheep in the same field as the horses. Spatial segregation between the different species was obvious and interactions between the adult horses and either cattle or sheep were rare. Only eight mare-to-cow and six mare-to-sheep interactions were recorded and these were all threats. Cattle submitted to seven threats and sheep to three. When the foals were between two and 12 weeks old they were interested in the cattle and sheep. If near to one of these animals a foal would approach, watch or explore it. Nine such foal-to-cow and 26 foal-to-sheep interactions were recorded. Sheep

submitted to the foals seven times but the cows did not react. On two occasions when a cow approached and sniffed a foal the foal submitted to the cow.

5:3:4 The reactions of foals to faeces and urine

5:3:4:1 Coprophagia

Mares were observed to defaecate on 167 occasions including adventitious recordings. The foals ate from 34 faecal piles, they explored 24 piles and did not react to 109 piles. An incident of coprophagia began when a foal started to explore a faecal pile and ended when the foal moved away from the pile. If the foal moved away from the faeces without eating any this was not recorded as an incident of coprophagia.

Thirty-four incidents of coprophagia were recorded including adventitious recordings. These incidents had a mean duration of 100 sec and a range in duration from 16 sec to 207 sec (Table 29). In 30 cases foals approached the faeces less than 1 min after the dams had defaecated. In three cases 3 to 5 minutes elapsed before the foals approached the faeces and in one instance coprophagia began 13 min after the mare had defaecated. In all cases the foals explored faeces for less than 1 min before eating them. During 20 incidents the foals also pawed the faeces before and between bites. The youngest foal seen eating faeces was Angel at 2 days old and the oldest foal was Caliban at 170 days of age,

TABLE 29 Details of incidents of coprophagia recorded during the observation periods and including adventitious recordings

Foal	Age when coprophagia was first and last seen	No. of incidents	Range in duration of incidents, sec	Range in elapsed time, sec
Jemma	3 - 27 days	7	35 - 203	0 - 45
Caliban	8 - 170 days	10	16 - 207	0 - 60
Captain Hook	3 - 94 days	6	65 - 175	0 - 776
Angel	2 - 85 days	7	71 - 177	0 - 340
Bashful	5 - 45 days	4	40 - 107	0 - 77
Total	2 - 170 days	34	16 - 207	0 - 776

just before he was weaned. Most of the incidents, 76%, were recorded from foals aged 6 weeks or younger (Figure 22). Foals only ate faeces deposited by their dams, eating from a pile once only with between one and 10 bites per incident. To enable the foals to reach the faeces they had to bend their knees, and after biting faeces the foals usually held their heads low with their muzzle in contact with the faeces or just above the pile. Three of the foals: Bashful, Angel and Caliban, aged 6 weeks, 12 weeks and 24 weeks respectively, stepped forward and urinated on to the faeces during or after an incident of coprophagia.

5:3:4:2 Marking behaviour

The filly foals were not interested in either their own or other horses' faeces or urine apart from the 18 incidents of coprophagia described in Section 5:3:4:1. There was only one occasion when a filly foal marked excrement (Table 30). The colt foals, on the other hand, marked adult mares' excrement from 4 weeks of age until they were weaned. There was only one instance of a foal marking a foal's excrement. Caliban, at 23 weeks old, sniffed Jemma's flank while she urinated and then marked her urine with urine. The mares were never observed to mark excrement.

Nineteen cases of marking behaviour were observed, 16 of which involved the foal marking its dam's faeces or

TABLE 30 Incidents of marking behaviour recorded from foals

Foal	No. of incidents	Mares' excrement marked		No. incidents in which the foal:		
		Urine	Faeces	Sniffed mare	Flehmened	Pawed
Captain Hook	11	9	2	9	7	2
Caliban	7	6	1	4	2	0
Bashful	1	0	1	0	0	0

urine and three cases in which the foal marked another mares' excrement (Table 30). In all instances the foals sniffed the urine or faeces and excreted on to it. The foals sometimes showed flehmen, pawed the ground or sniffed the mares' perineum during an incident. The duration of incidents ranged between 12 sec and 323 sec each being measured from the time the foal first sniffed the mare or excrement to the time the foal left the excrement.

5:3:5 Flehmen behaviour

Flehmen behaviour usually occured in connection with oestrous behaviour of the mares (Section 5:3:3:4:4) or the sniffing and marking of excrement (Section 5:3:4:2). All the animals except Kirsty, Angel and Bashful showed flehmen. Jemma at 4 days old was the youngest foal, and the only filly foal, observed to show it, and in this case she showed it after nursing. The only other incident of flehmen behaviour not previously described was by Caliban, at 12 days of age who performed flehmen after sniffing the ground.

5:3:6 The behaviour of the foals after weaning

All the foals were led into the stalls with no trouble except for Captain Hook which showed some reluctance. At first the foals whinnyed, quickly turned in small circles and pawed vigorously. Jemma even tried to jump out of her loose box. When the outer door to the stalls was

shut, and the mares removed, observation began.

During the first 30 min after weaning each foal whinnyed on average 15 times, often a call from one foal stimulating other foals to call. There were series of calls with some foals whinnying two or three times in succession and then standing alert listening for a few minutes.

During the first 4 hr after weaning the mean frequency of whinnying was 13 times per hour. On the second day this value had decreased to four whinnies per hour and by the third day none were heard from the foals.

Immediately after the foals had been shut in their loose boxes they were alert and showed signs of frustration by pawing vigorously, bucking and turning quickly in circles. Captain Hook also stood over his waterbucket, with his lips touching the edge of the bucket, and swung his head ventro-dorsally so that his lips repeatedly hit the edge of the bucket.

The foals' behaviour changed considerably between the first and the second day after weaning. On the first day the foals spent a large part of the observation period, 48%, standing alert, and 14% of the time in behaviour patterns that showed signs of frustration. By the second day only 1% of the observation period was spent in frustrated behaviour and more time was spent eating and resting

than previously and on the third day they showed no outward reaction to having recently been weaned (Figure 23).

5:4 Discussion

The maternal behaviour of mammals occurs in three phases (Shillito-Walser, 1977). The first phase occurs before parturition when the female becomes physiologically and behaviourally ready to respond to her offspring. The second and longest phase is lactation when the young depend on their mother for food and the third phase occurs at weaning when the young become independent of their mother. This section describes the behaviour of five mare-foal pairs from the first day of the mares' lactation until the foals were artificially weaned.

5:4:1 The activity of the mares

The restless behaviour of the mares on the first day after foaling and their readiness to defend their foals indicated that each mare had formed a bond with her foal by the time that observations began. In sheep and goats a strong bond between the mother and the offspring starts to develop immediately after parturition (Collias, 1956). Mares also show epimeletic behaviour immediately after birth but at first there is a stronger attraction to the foetal fluids and membranes than to the foal itself (Rossdale, 1968). However the foal-to-mother bond takes longer

to develop than the mother-to-foal bond (Waring, 1970). Since horses are the 'follower' type of ungulate the newborn foal has to distinguish its mother from other mares as soon as possible. This situation does not arise in the 'hider' types such as fallow deer, in which, during the hiding phase, the fawn has to respond only to the doe which approaches it closely (Gilbert, 1968) and roe deer fawns, for example, take 2 - 3 weeks to become imprinted, (Kurt, 1968).

One-day-old foals are unable to recognise their mother (Phillips-Powell, 1978) and free-ranging pony mares and zebra mares chase conspecifics away from their foals until the foals are 2 days old (Tyler, 1972; Klingel, 1969c). The bonds thereafter appear to be equally strong for mare and foal (Feist, 1971). In lambs - another follower type - the recognition of ewes as alien begins to develop within 24 hr of birth (Shillito and Alexander, 1975). However up to three days of age most lambs if separated from their mothers stand still to allow their mothers to find them (Shillito, 1975). Young wild asses in their first few days of life also have difficulty finding their dams (Rashek, 1976).

Even though they were spatially separated from other animals the five thoroughbred mares showed certain behaviour patterns which are typical of free-ranging mares with one-day-old foals. They were alert, kept themselves

between the foal and any source of danger, and threatened other animals. Tyler (1972) described the behaviour of mares with one-day-old foals as unlike any subsequent behaviour. Similarly the mares observed here were less restless by the second day post-partum and continued to settle as the foals grew older.

The increase in the restlessness of the mares and foals during Week 2 was partly caused by their management. Three mare-foal pairs were only in the field for a few hours per day during Week 2. Resting duration per hour recorded from these animals, in Week 2, was four times greater when they were stabled than when they were pastured. Since the duration of rest periods was greater than the duration of any other activity this contributed to a a decrease in the mean number of changes in activity in the stable and an increase in the field during Week 2.

The frequently changing activities of the foals during their early weeks occurred while the foals' diet was mostly milk and when they did not have to spend long periods grazing.

5:4:2 Feeding activities

5:4:2:1 Nursing activity - qualitative aspects

This information has been presented previously (see appended paper; Francis-Smith, 1978). Some aspects

of the foals' behaviour were similar to those recorded from other ungulate species. The reverse parallel nursing position is the usual one seen in ungulates although variations on this position are not abnormal (Lent, 1974). 'Heading-off' or the movement of the young round the front of the mother to make her stand still has also been observed in Mountain sheep, Marco-Polo sheep, cattle and in wild asses as well as in other horses (Feist, 1971; Geist, 1971; Le Neindre and Garel, 1977; Rashek, 1976; Walther, 1961). 'Pushing' the udder with the muzzle is also a common feature of nursing activity and its purpose is to encourage milk flow (Lent, 1974) and in the nursing activity of swine is essential for the production of milk (Shillito-Walser, 1977).

Initiation of nursing by young seems more common in the follower types than the hider types (Feist, 1971; Rudge, 1970; Tyler, 1972). However mothers of Mountain sheep call their lambs to nurse and female wild asses wake their foals and push them towards the udder if they have not nursed for a long time (Geist, 1971; Rashek, 1976). Various ways in which females help their offspring to nurse, particularly when very young, have been described. Pony mares stand still and flex the leg on the side away from the foal (Tyler, 1972). Wild ass mares hold their hind leg away from the body and lift it up while the foal nurses (Rashek, 1976) and feral horse mares step forward with their forelegs leaving their hindlegs

stationary to make the udder more accessible to the foal (Feist, 1971). As in this study others have reported that foals which are frustrated in their attempts to suck or cannot reach the udder paw the ground or paw and kick the mother (Rashek, 1976; Tyler, 1972).

The occurrence of nursing after a disturbance which was seen in these horses or after resting has also been reported in feral ponies, cattle and Soay sheep (Schloeth, 1961; Schoen et al., 1976; Shillito and Hoyland, 1971; Tyler, 1972). Foals may nurse after a disturbance because they find sucking comforting more than to relieve hunger (Tyler, 1972).

5:4:2:2 Nursing activity - quantitative aspects

The difference in nursing duration per hour between 09.00 hr and 15.00 hr may not have been a result of diurnal fluctuations. (Section 5:3:2:1:3), for the age range of the foals observed at 09.00 hr was from 1 to 6 days with a mean age of 3.25 days while at 15.00 hr the age range was from 5 to 7 days with a mean of 6.25 days. Since nursing duration decreases rapidly during the first weeks of a foal's life (Tyler, 1972) the observed difference was probably a result of an age difference in the foals rather than a diurnal fluctuation in nursing activity.

Information on the frequency and duration of nursing activity in different ungulate species has been recorded.

In a recent review it is emphasised that authors do not always make it clear whether their results relate to bouts or to sucking events within bouts (Lent, 1974). The range of values recorded by different workers for frequency and duration of foals' nursing bouts may reflect either differences in techniques used or differences between breeds. Tyler (1972) recorded nursing bout duration as the time 'from when the foal stopped pushing violently against the udder wall until it finally released the nipples'. Interruptions were subtracted from the total bout length. This gave a mean frequency of four bouts per hour with a median length of 71 secs from one-week-old pony foals. Wild ass foals are reported to nurse 12 times per hour during the first 5 days of life with bouts varying between a few seconds and 2 min in duration. Dutch warm-blooded saddle horse foals nursed with a mean bout duration of 1.3 to 1.7 min (Bouwman et al., 1978). The foals of heavy brood mares had a mean frequency of 3 to 4 nursing bouts per hour during the first week post-partum (Martin-Rossett et al., 1978), and Klingel and Klingel (1966) observed a zebra foal nurse 12 times during its first 4 hr of life with the bouts ranging from 30 sec to 2.5 min in duration. Rogalski (1973) observed differences between the nursing frequency of arab, anglo-arab and thoroughbred foals but did not specify if the foals were all observed at the same age. The thoroughbred foals, observed in this

experiment, nursed relatively often; seven times per hour with a mean bout duration of 105 sec; during the first week post-partum. However the mean sucking time of 84 sec during the five successful nursing bouts per hour is more comparable with Tyler's results than total nursing duration, due to Tyler's recording techniques. It is not obvious why nursing time should vary between the different types of foals. Body weight does not seem to be a primary determinant of nursing duration. Wild ass foals had a higher nursing time and a lower body weight than the thoroughbred foals observed here while heavy draught foals weighed more but nursed less (Martin-Rossett et al., 1978; Rashek, 1976). The close confinement of the thoroughbred mare-foal pairs during Week 1 may have induced more nursing than if they were at grass, but since there was no significant difference in nursing time per hour between recordings made in the stable and the field during Week 2 it seems unlikely that stabling affected nursing time.

Varying nursing times are likely to be due to differences in the recording techniques used, the breed of horse, the quality and quantity of milk obtained and the capacity of the udder. Certainly nursing time is not a measure of food intake. As already stated, sucking behaviour alone without obtaining any milk can be comforting for the young (Shillito-Walser, 1977; Tyler, 1972), Adler and Linn and Moore (1958) reason that nursing activity

satisfies both the nutritive needs and the non-nutritive emotional needs of the offspring.

In contrast to the Equidae other ungulate species nurse infrequently. Twin lambs nursed 1.6 times per hour (Ewbank, 1964), caribou calves nursed 10 times per day (Lent, 1966) and young beef calves nursed 3 - 5 times a day during the first week post-partum (Walker, 1962). The hider types of ungulate offspring nurse even less often during their first week. Red deer calves have two to four nursing periods a day (Clutton-Brock and Guinness,1975) and water buck young nurse only once a day (Spinage, 1969). However despite differences in the frequency and length of nursing period Munro and Inksen (1957) concluded that lambs which were restricted to nursing once per four hours received as much milk as lambs nursing once per hour.

It is generally agreed that nursing duration decreases as offspring grow older (Lent, 1966). Most workers describe this change as a result of decreasing nursing frequency rather than a shorter bout length (Ewbank, 1969; Feist, 1971; Rashek, 1976). This was the case found here and Martin-Rossett et al., (1978) showed that the change in nursing bout frequency followed an exponential curve similar to that shown in Figure 11A.

The thoroughbred foals showed no change in nursing bout frequency between the fourth and sixth months after birth.

However changes in the nursing frequency of New Forest pony foals only ceased at 8 months of age after which the foals nursed once every 2 hours until the time they were weaned (Tyler, 1972). This may reflect differences in the level of nutrition which each group received. The only source of food for the ponies was the heavily over-grazed pastureland of the New Forest whereas the thoroughbred foals could share their dam's corn feed and the pasture in Field 6 was abundant and of good quality. Therefore possibly at 4 months of age these foals could maintain their intake of grass and oats and so they reduced their nursing time accordingly. For the ponies however their dam's milk could be an important food source for a longer time since the only alternative was to spend long periods each day grazing.

In contrast to the foals' decreased nursing frequency the milk yield of mares increases with time after parturition to a peak. Dutch warm-blooded saddle mares reached a peak production of 18 kg milk per day in the tenth week of lactation (Bouwman and Schee, 1978). Foals take advantage of this extra milk by being able to swallow more quickly as they grow older (Rogalski, 1973).

Variation in the duration of foals' nursing bouts, between a few seconds and several minutes, has been reported

(Feist, 1971; Klingel and Klingel, 1966; Rashek, 1976; Tyler, 1972). Data obtained in this experiment indicated that one week old foals are unlikely to achieve sucking during a nursing bout less than 40 sec in duration (Figure 11), despite the fact that at this time the mare does not 'resist' the foal's nursing attempts. The young foals appeared to have poor motor co-ordination and they seemed to be 'fumbling' in their attempts to find a teat. A subjective impression gained during the experiment was that as the foals grew older they became more efficient at nursing and by Week 6 a greater proportion of the nursing bout was spent sucking than that recorded in Weeks 1 and 2. This is probably due to better motor skills in the older foal and is partly corroborated by the decreased proportion of nursing time spent in 'interval behaviour' (Figure 12). In addition the nursing bouts recorded during Weeks 6 to 24 were more uniform in length than those recorded in Week 1 (Figure 10). Unfortunately it was not possible to record the rate of sucking while the foals nursed as this would show, to some extent, the amount of milk the foals received.

Sucking in 'bursts' from each teat has been reported in young wild asses (Rashek, 1976) and in the data reported here it is interesting to note the uniformity of mean 'burst' duration between the foals and between each teat (Table 20).

The foals made more successful nursing bouts from the right side than the left side of the mares when they were stabled. This may have been influenced by the position of the hay, water and door and hence the places where the mares were likely to stand. Thus if a mare's left side was usually against a wall her foal would be more likely to nurse from the right side. In the field the foals nursed an equal number of times from each side and there are no reports on this subject in the literature.

5:4:2:3 Mother-foal interactions during nursing activity

The mares' lack of tolerance to nursing activity during Weeks 2 and 3 was probably a result of the foals' high 'push' frequency in Week 2. This 'pushing' or bunting has been described by Lent (1974) as occurring almost universally amongst the ungulates. Zaks (1962) observed that it encourages milk flow in the same way as oxytocin but that this activity appears painful to the mother and she may threaten her offspring to discourage it from nursing. The high frequency of mares' 'resistances' in Weeks 2 and 3 (Figure 13A) was accompanied by the lowest proportion of time that the mares stood still with a hind leg flexed (Figure 16), a high proportion of nursing bouts ended by the mares (Figure 15) and a high proportion of nursing time spent in 'interval behaviour' by the foals (Figure 12). Tyler (1972) described how pony mares hindered foals' sucking attempts by biting, stamping or

kicking or by continued grazing while the foals nursed and these mares also showed the least co-operation with their foals' nursing attempts during Weeks 2 and 3, after birth.

Other workers describe how ungulate mothers become less tolerant of nursing activity as the offspring age (Espmark, 1969; Martin-Rossett et al., 1978; Rashek, 1976). They consider this to be the beginning of weaning. In Week 24 the thoroughbred mares showed more 'resistance' to the foals' nursing activity and ended more bouts than in the previous few weeks. This was also reflected by an increase in 'interval behaviour' (Figure 12). Unfortunately, it was not possible to observe whether or not this trend continued towards a natural weaning process because the foals were artificially weaned. However, free ranging mares do not usually wean their foals until shortly before their next parturition and the weaning process is usually abrupt (Feist, 1971; Tyler, 1972; Welsh, 1973). The mares rarely licked their foals while they nursed and this was not an important activity unlike the licking of offspring by female fallow deer, caribou and roe deer (Espmark, 1969; Gilbert, 1968; Lent, 1966).

5:4:2:4 Eating hay, eating oats and grazing behaviour

It is not known how far the ability of foals to eat is related to the eruption of their teeth. Presumably it

is necessary for the two central incisors to erupt before a foal is able to graze and this usually occurs during a foal's first week (Miller and Robertson, 1959). Accordingly foals start to graze during the first week after birth (Martin-Rossett et al., 1978; Rashek, 1976; Welsh, 1973) but one-day-old pony foals suck and nibble at vegetation then drop it (Tyler, 1972). The eruption of a foal's teeth continues during the second to fourth week with the appearance of two lateral incisors and molars 1, 2 and 3, all of which are temporary (Miller and Robertson, 1959). The thoroughbred foals observed in 1976 and 1977 started to eat hay between 3 and 8 days of age and oats between 11 and 19 days. This suggests that either the criteria used to assess when foals start to eat hay were incorrect or that foals can chew small amounts of hay without molars, but that molars are essential for foals to chew oats adequately in order to swallow them. It is thought that the latter is the case, since the only sign of a transition from exploring hay to eating hay was the onset of a regular biting and chewing of hay without dropping lumps of chewed hay.

All the thoroughbred foals observed in 1976 and 1977 started to graze within 30 min of being turned out to grass with their dams. In contrast orphan foals alone do not graze until they see an adult pony grazing (Glendinning, 1977). This point makes it interesting to consider how much a foal learns from adult horses.

In effect this reflects on the gregarious nature of horses and the fact that feral and wild foals are always in the presence of an adult.

5:4:3 Social interactions

5:4:3:1 Interactions within a mare-foal pair

The proximity of young to their mothers in follower type ungulates is maintained largely by the actions of the young (Feist, 1971). This situation was suppressed in this study until the mare-foal pairs were turned out to grass. During Weeks 1 and 2, while the mare-foal pairs were stabled, the enforced proximity of the mare and foal probably induced more mare-to-foal interactions than normal and removed the need for the foal to maintain contact with its dam by frequent follows and approaches. When in the field the mares apparently took little interest in their foals and even when the foals were lost the mares did not hurry to find them. This may have been because the foals were never completely out of sight and sound of the mares. Tyler (1972) described how foals, and even yearlings, approached the wrong mare to within 5 yd before realising their mistake when looking for their dams. Feist (1971) observed that a feral horse stallion would force a foal to stay with its group or would find it if it was lost.

The decreased frequency of foal-to-mare interactions as the foals grew older is a reflection of the foals'

increasing independence. Also foal-to-mare approaches were reduced as a result of the decreased nursing frequency with age (Figure 11A). Similarly New Forest pony foals play a decreasing role in maintaining proximity with their dams as they grow older. However they are still responsible for maintaining contact at the end of their first year (Tyler, 1972).

5:4:3:2 Interactions other than those within a mare-foal pair

Dominance hierarchies have been described for several types of horses. Descriptions vary from well defined hierarchies in highland ponies (Clutton-Brock et al., 1976) to the absence of a consistent rank order in feral mares (Feist, 1971). The linear hierarchy found among the thoroughbred mares was consistent with hierarchies observed in small herds of domestic horses (Houpt, 1978) and in the family groups of non-territorial free-living Equidae (Klingel, 1974a; Welsh, 1973). The exception to this was Kirsty whose aggression towards Gay and Emma occurred when Captain Hook was only two weeks old. Similarly other ungulate mothers show more aggression towards adult conspecifics during the early life of their young (Espmark, 1969; Lent, 1966).

Some workers have related the position of a horse in a hierarchy to the horse's age (Collery, 1969; Montgomery, 1957; Tyler, 1972), to its body weight (Houpt, 1978;

Montgomery, 1957; Tyler, 1972) and to its sex; males tend to be dominant to females; (Montgomery, 1957). Length of residence in a group does not seem to affect the horses' ranks in that group (Montgomery, 1957; Tyler, 1972). Neither age nor body weight appeared to affect the rank order of the thoroughbred mares (Table 31). Houpt (1977) stated that temperament was the most important characteristic in determining rank order. Aggression was not recorded here but a subjective impression was that Polly went out of her way to threaten other mares in situations in which a threat was unnecessary. Clutton-Brock et al., (1976) noticed that the behaviour of a top-ranking pony mare tended to differ from that of other herd members: she lacked friendly relationships typical of the others but despite her unsociability she spent little time alone or in small groups and this was also true of Polly.

As might be expected Polly, at the top of the hierarchy, made the most threats and Kirsty, at the bottom, made the most submissions. The bottom of the hierarchy was as well formed as the top as reported by Houpt (1978) but unlike that in the New Forest pony groups (Tyler, 1972).

Although the foals showed submissive gestures from one week of age their submissive response to adult threats occurred more often as they grew older (Table 28). The

TABLE 31 The dominance hierarchy, age and weight immediately after parturition, of the mare

	Polly	Emma	Gay	Flatspin	Kirsty
Dominance rank	1	2	3	4	5
Age, yrs	9	7	12	10	11
Weight, kg	553	510	455	523	693

threat expression was not shown by foals until they were eight weeks old and even then there was very little aggression between the foals. Houpt (1978) also observed that horses less than three years old were less aggressive than adult horses and it is possible that animals become more aggressive when they are sexually mature. On the other hand Tyler (1972) recorded threats from New Forest foals during their first few days of life.

In agreement with Tyler (1972) a stable hierarchy had not developed amongst the foals by the time that they were six months old. Glendinning (1977) however reported that orphan foals quickly formed a hierarchy and sucked from a milk machine in their rank order. It may be that either a rank order is present in all young foals but is not expressed until there is limited access to a desired object or that the limited access to the milk machine - only one foal could suck at a time - caused the development of a hierarchy in the orphan foals earlier than usual. Amongst the thoroughbred foals it seemed that Jemma, Captain Hook and Angel, the three heaviest foals were dominant to Caliban and Bashful. Therefore Captain Hook's position did not seem to be affected by Kirsty's low rank. Interestingly Houpt (1978) observed that although the offspring of dominant mares were dominant within their own herds, in general low-ranking mares do not necessarily have a low-ranking offspring.

Summarising these results it was found that a foal did not automatically have the same rank as its mother and all the foals were subordinate to all the mares. The only times when a mare tolerated the approaches and explorations of an alien foal was if the foal's dam, a more dominant mare than herself, was within 1 or 2 m of her.

5:4:3:3 Play behaviour

Qualitative aspects of the foal's play behaviour were similar to those described by Tyler (1972) for New Forest pony foals. Solitary play occurred during the foals' early weeks and group play began after Week 4. Lone play amongst roe deer fawns also occurs more often during the first week of life than subsequently (Espmark, 1969). Since it is believed that foals play more in the early morning or evening than at other times (Feist, 1971; Schoen et al., 1976) the thoroughbred foals probably played more often than was indicated by the observations. To emphasise this fact Schoen et al., (1976) reported an average of three 'games' per hour during daylight hours from each foal while only one 'game' per seven hours was observed here. Since foals that are born within 10 days of each other tend to play together (Schoen et al., 1976) this could be why Bashful, six weeks younger than the other foals, spent such a small amount of time playing with others.

Muller-Schwarze (1971) has reviewed the literature on play

behaviour and states that

> ... the amount of time and paper spent on speculations on possible functions of motor play in immature animals is in inverse proportion to the amount of facts available on this question.

It seems to be well accepted that play behaviour is an expression of a general motivational state for activity and that the behaviour components involved in certain play activities may not be unique to play but constitute parts of behaviour sequences belonging to other activities in a different context (Meyer-Holzapfel, 1956).

During solitary play the foal usually galloped in circles and appeared to be exercising muscles and developing skills which, in a wild herd, could be necessary should the herd have to flee. In addition, many of the movements shown by foals in mutual play are fighting movements such as kicking, rearing, chasing and turning to face each other then shaking their heads and biting at one another. All these movements were carried out without a facial threat expression and individual foals neither won nor lost these encounters. It is thought that play behaviour allows foals to practise certain behaviour patterns which are not among the daily maintenance activities of horses but which are vital to the survival of the species. In particular the male foals spend more time in mutual play than the females and when adult are involved in more antagonistic encounters in the wild (Schafer, 1975; Welsh, 1973).

5:4:3:4 Sexual behaviour

There was very little evidence of sexual development in the foals during the experiment. Mounting of adults by foals rarely occurred. Captain Hook was interested in Flatspin while she was in oestrus but he did not have his penis extended or attempt to mount her. Similarly Tyler (1972) observed that New Forest pony colts had little interest in oestrous mares although full erections of the penis in two or three month old colts were common.

5:4:3:5 Interactions with other species

Like the New Forest ponies (Tyler, 1972) the adult mares were almost always dominant over the cattle and the foals subordinate to them. However the sheep tended to be subordinate to both the mares and the foals. The mares even threatened sparrows in the stable during the first few days after the foals' birth. Mares may be physiologically prepared to chase away from their foals anything that moves during the first few days after birth to ensure that the foal is correctly imprinted. However, in the confinement of the stable this drive is little used and so it is released by stimuli which would otherwise be ignored - in this case the sparrows.

5:4:4 The reactions of foals to faeces and urine

5:4:4:1 Coprophagia

Baintner (1971) describes coprophagia as occurring in herbivorous animals, in which carbohydrate fermentation

occurs after food has passed through the stomach and small intestine e.g. rats and rabbits. He states that since horses have this type of digestion it is surprising that they are not coprophagic. Certainly it occurs as a normal behaviour pattern in some adult ungulates of the hider type of species, when the mother eats the faeces of the offspring during its hiding phase to reduce the chances of predators finding the young (Clutton-Brock and Guinness, 1975; Spinage, 1969). In the follower type of ungulate these precautions are unnecessary and adult Equidae normally reject the faeces of their own species (Hafez, Williams and Wierbowski, 1969). Zebra, wild ass, pony and horse foals, however, are reported to eat fresh faeces deposited by their dams (Francis-Smith and Wood-Gush, 1977; Klingel, 1972b; Rashek, 1976; Tyler, 1972). This is believed to be a normal part of the foals' development which provides them with bacteria essential for the digestion of fibre (Baintner, 1971). Baintner also observed changes in the faeces of foals which indicated that cecal and large intestinal fermentation began at one month of age. In agreement with this statement most incidents of coprophagia occur during the first four weeks of life but it is not unusual for foals up to 14 weeks old to eat their mothers' faeces (Figure 22; Tyler, 1972).

The last two instances of coprophagia, recorded on 8th September 1977 and 6th October 1977, were from Caliban when he was 20 and 24 weeks old. At these times Caliban was

receiving a course of antibiotic injections (Streptopen) to treat a nasal discharge. The injections were given once a day from 1st September to 6th September and also on 5th and 6th October. It is possible that the antibiotics killed the bacteria in Caliban's gut and that Caliban then ate his mother's faeces to restore the balance of gut flora at an age when coprophagia would not normally occur. In addition adult horses, having received a course of antibiotics, eat their own faeces (Kempson, 1977). This indicates that there could be a specific hunger for gut flora and accordingly it would be of interest to know whether coprophagia occurs in orphan foals reared in isolation from adults and whether they suffer nutritional deficiences when they are unable to eat adult horse faeces.

5:4:4:2 Marking behaviour

Marking behaviour mainly by male animals occurs in the equine species (Klingel, 1974a). The formation of dung piles by both territorial and non-territorial males is thought to provide visual markers and information about population density for conspecifics (Feist, 1971; Klingel, 1972a; Welsh, 1973). However the marking of mares' excrement by males, although well documented (Klingel, 1968a; Tyler, 1972) has not yet been explained.

5:4:4:3 Flehmen behaviour

Flehmen behaviour occurs in most of the equine species:

Shetland and Welsh ponies (Schoen et al., 1976), New Forest ponies (Tyler, 1972), feral horse stallions (Feist, 1971), Przewalski's horse (Dobruruka, 1961), Plains zebra stallions (Klingel, 1969a) and in Grevy's zebra and Mountain zebra stallions (Klingel, 1968a). The youngest foal reported to show flehmen was 30 min old (Schafer, 1975).

It is generally believed that flehmen is a response to olfactory stimulation since in most cases it occurs after the animal has sniffed either excrement or an oestrous female. The taste of a strong flavoured substance such as cough medicine can cause a horse to show flehmen (Houpt, 1977). However the function of flehmen behaviour is unknown. Flehmen is shown more often by males than by females which is not surprising since males pay more attention to excrement and to oestrous mares than females do (Feist, 1971).

Flehmen behaviour recorded here was shown mainly by the colt foals and by the mares during oestrus. The occurrence of flehmen in oestrous mares may indicate that they are either more interested in or more sensitive to odours during the oestrous period.

5:4:5 Weaning

The term weaning is often used to refer to two different stages in a foal's development: the cessation of nursing

activity and the breakdown of mother-infant bonds. Domestic foals are usually weaned by an enforced separation of the mare and foal thus completing both stages at once. In contrast among wild populations adult mares normally discourage nursing activity when a foal is one year old and just prior to the mare giving birth again (Tyler, 1972). The mother-foal bonds remain intact however and it is not until the juveniles reach adolescence between two and four years old that they leave their family group. Little is known about the natural breakdown of mother-infant bonds. Amongst free-ranging Equidae the female adolescents are abducted from the family group by strange stallions and males are either rejected by their own family stallion or leave of their own accord (Klingel, 1974a; Welsh, 1975). The domestic situation is obviously more stressful for both the mare and the foal. In the case of the thoroughbred mares and foals the foals were suddenly removed from their dams and put into a strange environment. The immediate reaction of the foals was to escape but when they found this impossible they expressed frustration in various ways. Despite the 'shock' of this type of weaning the foals outwardly appeared to have settled by the time that 48 hr had elapsed. However it would be more interesting and accurate to take physiological measurements of stress at this stage since behaviour, particularly in the restricted environment of the stalls does not accurately reflect an animal's level of stress. It is thought that stress at weaning

for domestic foals is minimal if mare-foal contacts are gradually reduced and contact with peers is allowed (Waring et al., 1975).

5:5 Summary

Finally, summarising these results, it can be said that in certain aspects the behaviour of the mares and foals was similar to that reported in other breeds - the mares were particularly alert on the first day after parturition and they initially helped the foals to nurse but later rejected them. The foals were responsible for maintaining contact with their dams in the field and initiated all nursing activity. It was found that periods of nursing behaviour occur grouped together and these groups were defined as nursing bouts. Differences between the behaviour of these mare-foal pairs and that of other breeds reported in the literature may be due to differences in either recording techniques, management systems or the breed of horse.

All the foals showed coprophagia at an age which is considered normal for this behaviour. In addition one foal was seen to eat its mother's faeces outwith this period and it was suggested that this foal's gut flora had been affected by a course of antibiotics and he then ate faeces to restore the balance.

A linear hierarchy was apparent among the mares but the

foals showed little aggression to one another and had not established a hierarchy before they were weaned at six months old. Weaning was a stressful event and differed considerably from the natural weaning and breakdown of mother-infant bonds of free-ranging Equidae. Despite this the foals appeared to have recovered by the time that 48 hours had elapsed from their separation.

6 THE ELIMINATIVE BEHAVIOUR PATTERNS OF HORSES FED SUPPLEMENTARY HAY IN PADDOCKS, OCTOBER 1975

6 The eliminative behaviour patterns of horses fed supplementary hay in paddocks, October 1975

6:1 Introduction

Fields grazed solely by horses develop characteristic areas of short and long grass (Archer, 1972b). Normally horses graze the areas of short grass - lawns - and use the long grass - roughs - for excretion (Odberg and Francis-Smith, 1976). Casual observation indicated that the eliminative behaviour patterns of the horses changed when hay was fed scattered on the ground in paddocks and it was hoped that further observations on the horses in this situation could confirm and possibly explain this change in behaviour.

6:2 Materials and Methods

6:2:1 Subjects

Two groups of horses were observed in this study. Group A - Kirsty, Flatspin, Polly and Emma - was kept in Field 5 and Group B - Gay and Nyse and their foals Effie and Toby - was pastured on Field 1 (Table 32).

Kirsty who had foaled on 3rd May 1975 was included in Group B until 16th October 1975 when her foal died. She was then stabled for four days and put into Group A on 20th October 1975.

6:2:2 Management of the subjects

As available grazing was very poor hay was fed ad lib. to the horses and was supplied to Group A at 08.30 hr and 16.00 hr, and

TABLE 32 Details of the horses that were observed

Mare	Year of Birth	Believed in Foal	Av. wt. during Expt. (kg)	Date of birth of Foal	Foal	Av. wt. of Foal (kg)
Emma	1970	Yes	546	-	-	-
Flatspin	1967	No	550	-	-	-
Kirsty	1960	No	630	3.5.75	Sundance	-
Polly	1968	Yes	552	-	-	-
Gay	1965	No	456	29.4.75	Effie	190
Nyse	1968	Yes	420	14.6.75	Toby	135

to Group B at 08.00 hr and 16.30 hr. To avoid intense competition the hay was scattered on the ground over an area approximately 30m x 10m. In addition Nyse and her foal, Toby, were fed 1.5 kg oats at 14.00 hr from a bucket held by an assistant who also discouraged Gay and Effie from approaching the bucket.

Field 1 had been reseeded in 1973 and was not grazed by horses between 1973 and May 1975. Field 5 had been regularly grazed by horses since April 1974 and had definite areas of lawns and roughs while there were no distinct lawns and roughs in Field 1.

Gay, Nyse, Effie and Toby were removed from the field once weekly to be weighed and measured and observations were not made on those days.

6:2:3 Behaviour recordings

Observation periods lasting 30 min each were randomly distributed to cover the period between 08.00 hr and 17.00 hr but observations on the two groups were not simultaneous. All observations on the two groups were completed between 22nd October and 13th November 1975. During these observation periods the behaviour pattern of each horse was recorded at 5 min intervals using the method of intermittent observations (Ewbank, 1967). Furthermore a detailed account was made of all excretions seen during the observation periods.

6:3 Results

6:3:1 Behaviour patterns between 08.00 hr and 17.00 hr

The behaviour patterns that were recorded are listed in Table 33.

TABLE 33

The behaviour patterns recorded during the observation periods

Behaviour Pattern	Definition
1. Grazing	The animal bit, chewed and swallowed grass
2. Eating hay	The animal bit, chewed and swallowed hay
3. Eating oats	The animal bit, chewed and swallowed oats
4. Drinking	The animal drank from the water supply
5. Nursing	The foal reached up with its muzzle towards its dam's udder.
6. 'Other behaviour patterns'	The animal showed any behaviour pattern other than those described above

Group A spent an average of 91 per cent of the 9 hr feeding, and Group B adults and foals respectively spent 84 per cent and 70 per cent of the time feeding (Table 34). Most of the time spent eating hay occurred immediately after fresh hay was supplied, for Group A at 08.00 hr and 16.30 hr and for Group B at 08.30 hr and 16.00 hr.

6:3:2 Excretory behaviour

A total of 44 defaecations and 18 urinations were observed. The horses in Group A defaecated 18 times and urinated 6 times on lawns. The adults in Group B defaecated 16 times and urinated twice, while the foals defaecated 8 times and urinated 9 times in Field 1 where there were no obvious roughs.

Four excretions by adults were surrounded by the following sequence of behaviour patterns: a horse stopped a behaviour pattern, moved to a different place, stood still and excreted then moved to a different place and began another behaviour pattern. Polly excreted on three of these occasions on roughs, the fourth occasion was Nyse who also explored the ground after having urinated.

The remaining 41 excretions by the mares were deposited while the mares grazed, stood still or ate hay. An interruption in the current behaviour pattern only occurred when a mare stopped grazing or eating hay and stood still to urinate. The foals excreted 17 times. On one occasion Toby stopped eating hay, walked to a different place, stood to defaecate, walked away sniffing other piles of faeces and then stood still. The remaining 16 excretions by foals occurred with no interruption in the current behaviour

TABLE 34 The mean time that the horses spent in each behaviour pattern expressed as a percentage of 9 hr

	Grazing	Eating hay (& eating oats)	Drinking	Moving	Resting	'Other'
Group A	23	68	1	-	2	6
Group B adults	19	65	2	-	9	5
Group B foals	18	52	1	1	17	11

pattern (Table 35).

6:4 Discussion

A total of 45 adult excretions were observed, of which four were surrounded by a similar behaviour pattern sequence to that reported by Odberg and Francis-Smith (1976). On these four occasions the horses never explored the ground before excreting and only once a horse explored the ground after it had urinated. Three of these excretions occurred on roughs and were passed by the same horse, Polly, but the majority of adult excretions (41) occurred with minimal interruption in the current behaviour. Twenty-three defaecations and seven urinations fell onto and around the hay, soiling the food and the area of lawn on which it had been scattered (Plate 4) and a further ten piles of faeces were deposited on the lawns.

Adult male horses are more selective than females in choosing to excrete on roughs (Odberg and Francis-Smith, 1977) and the fouling of lawns observed in this experiment might have been due to the absence of adult males. However this seems unlikely as adult hunter mares, in the absence of adult males, were observed to excrete 46 times on roughs and only twice on lawns (Francis-Smith, 1974) suggesting that the absence of adult males was unlikely to have influenced the excretory behaviour of the thoroughbred mares observed here.

The presence of faeces discourages horses from grazing nearby (Odberg and Francis-Smith, 1977) but urine does not affect the

TABLE 35

The frequency of defaecations, d, and urinations, u, that occurred with minimal interruption in a behaviour pattern

		Eating hay	Grazing	'Other'
Adults	d	23	10	1
	u	7	0	0
Foals	d	4	2	1
	u	3	1	5

palatability of grass to horses (Archer, 1978). It seems likely that when a horse is grazing it detects faeces by scent and since the lawns are normally free of excrement there will be a change in scent when the horse approaches a rough. When hay was fed in a restricted area this may have created competition between the horses for the food which reduced the motivation to leave and defaecate in a different area. As a result the horses soiled the hay and surrounding area with faeces. Having fouled the hay area the horses may have become adapted to the scent of faeces and could not distinguish the roughs from the hay area.

After eating hay the horses usually started to graze near the hay area and moved slowly away from it. Therefore this adaptation to the smell of faeces may have caused them to soil the lawns as they gradually moved away from the hay area (Plate 5). The lawns at the far end of Field 5 were not littered with faeces because either the horses had become dis-adapted and could once again distinguish the lawns from the roughs at this distance from the hay or because they spent less time there.

Generally foals do not show a strong tendency to group excrement (Odberg and Francis-Smith, 1976) and the eliminative behaviour patterns recorded from these foals was not thought to be unusual.

When hay is fed to horses in paddocks it can either be scattered on the ground or fed from hayracks. In this case the hay was scattered on the ground and there was considerable wastage of hay which was soiled and trampled on by the horses and then left

uneaten. In addition to the loss of hay most of the area on which it had been fed had developed into roughs and paths by May 1976, when Field 1 was still grazed by horses, and this could have been because of the many piles of faeces deposited on the area when hay was fed there.

An argument against the use of hay racks in paddocks is the destruction to the sward caused by the concentration of animals in a small area. The solution to feeding hay to horses in paddocks may be either to use permanent hay-racks in areas where paths are likely to develop, near a gate for example, or to use an easily moveable hayrack which can be moved every day thus preventing physical damage and spreading fouling over the pasture.

Unfortunately the management of the animals and paddocks was outwith the control of the experimenter and it was not possible to test the effect that feeding hay from a hayrack might have had on the eliminative patterns of horses.

7 THE BEHAVIOUR OF A GROUP OF MARES DURING ONE 24 HR PERIOD IN FEBRUARY 1975

7 The behaviour of a group of mares during one 24 hr period in February 1975

7:1 Introduction

Little is known about the activity of horses during periods of 24 hours. Tyler (1972) believed that most of the hours of darkness were spent feeding and Feist (1971) also observed horses feeding at night. A large proportion of the daily food allowance is fed to stabled horses in the early evening and therefore a large part of the night is probably spent feeding. However there is no firm evidence as to how stabled horses distribute their feeding periods over 24 hr and this experiment was designed to throw some light on this.

7:2 Materials and methods

7:2:1 Subjects

Five mares - Melody, Polly, Kirsty, Willow and Emma were observed in this study (Table 36).

7:2:2 Management of the subjects

The mares were housed in the stalls at night and pastured on Field 4 between 08.45 and 16.45 hr. Since the grass in Field 4 was sparse at the time of the experiment hay was provided ad lib. from a hayrack. In the stalls each horse received hay in an individual hay net and 20l. of water at 16.45 hr. Therefore the horses received fresh hay at 08.45 and 16.45 every day and these times will be referred to as supply times.

A light was left on in the loft above the stalls, with the loft

TABLE 36

Details of the horses

	Year of Birth	Believed in foal	Av. wt (kg)	Av. wt hay eaten per night (kg)
Melody	1966	Yes	510	12.00
Polly	1968	No	485	9.00
Kirsty	1966	Yes	720	12.30
Willow	1962	No	519	7.90
Emma	1970	No	465	8.30

hatch open, for two weeks before the experiment, and during the experiment to allow the animals to be seen at night without the use of a torch.

7:2:3 Behaviour recordings

One 24 hr period was split randomly into three observation periods of 8 hr in duration. The observation periods were made on three consecutive days (Table 37). The times of dawn and dusk were 08.00 hr and 16.45 hr.

During an observation period the behaviour pattern of each horse was recorded at 15 min intervals using the method of intermittent observations (Ewbank, 1967). Three behaviour patterns were recorded; eating hay, grazing and resting. The last mentioned behaviour was recorded as resting standing or resting lying while a fourth group called 'other' behaviour included the minor behaviour patterns which were standing, moving, excreting, drinking and social behaviour patterns.

The weight of hay that each horse ate in the stall was measured on the three nights during the experiment and excretions observed in the stalls were recorded.

7:3 Results

7:3:1 The time spent in each behaviour pattern

The mean time that each horse spent in the three major behaviour patterns was as follows: 13hr 30 min eating hay, 2 hr 00 min grazing and 6 hr 45 min resting which includes 45 min resting

TABLE 37

Dates and times of the observation periods

Observation Period	Date	Time	Outside temperature °C Max.	Min.
1	3.2.75	15.00hr - 23.00hr	12.0	-0.5
2	4.2.75	07.00hr - 15.00hr	6.5	0.0
3	5.2.75	23.00hr - 07.00hr	3.5	-4.5

lying. The 'other' behaviour patterns occupied 1 hr 45 min of the day and these consisted of 1 hr 15 min standing, 0 hr 15 min moving and 0 hr 15 min excreting and drinking (Table 38).

7:3:2 The diurnal distribution of behaviour patterns

7:3:2:1 Feeding behaviour

The mean length of a period of eating hay was 70 min and each horse had a mean of 11.5 such periods during the 24 hr. Most of the time spent eating hay, 9.00 hr, occurred while the horses were stalled when each horse ate an average of 9.9 kg hay. The longest periods of eating hay occurred immediately after the supply times when the mean length of the first period of eating hay was 20 min after the 08.45 supply and 180 min after the 16.45 hr supply.

In contrast grazing behaviour occurred in periods of shorter duration: the mean number of periods being four each lasting an average of 30 min.

Although daylight hours were only 36 per cent of the 24 hr there was relatively more feeding then; 43 per cent of feeding behaviour occurred during daylight compared with 57 per cent during darkness.

7:3:2:2 Resting behaviour

The horses had an average of nine rest periods each, with a mean duration of 45 min during the 24 hr. Four of the horses began the longest rest at 04.00 hr but Kirsty rested at 04.00 hr, ate hay at 04.30 hr and began the longest rest at 05.15 hr. The majority of resting behaviour, 87 per cent, occurred during the hours of

TABLE 38 The time that a group of mares spent eating hay, grazing, resting and in 'other' behaviour patterns during one 24 hr period, February 1975

	Melody	Polly	Kirsty	Willow	Emma	Mean
Eating hay	13hr 45 min	12hr 00 min	14hr 30 min	13hr 30 min	13hr 15 min	13hr 30 min ± 25 min
Grazing	03hr 45 min	03hr 00 min	01hr 00 min	01hr 15 min	01hr 30 min	2hr 00 min ± 30 min
Resting standing	04hr 30 min	06hr 00 min	05hr 45 min	07hr 00 min	06hr 30 min	6hr 00 min ± 25 min
Resting lying	00hr 45 min	01hr 00 min	00hr 15 min	00hr 30 min	01hr 15 min	0hr 45 min ± 10 min
'Other' behaviour	01hr 15 min	02hr 00 min	02hr 30 min	01hr 45 min	01hr 30 min	1hr 45 min ± 10 min

darkness which occupied 64 per cent of the 24 hr period and in the case of two mares, Melody and Kirsty, all resting occurred during darkness.

An average of 45 min was spent lying down and while Emma lay down twice the other four horses only lay down once and all recumbency occurred between 23.00 hr and 06.15 hr (Figure 24).

7:3:2:3 'Other' behaviour patterns

An average of five periods of 'other' behaviour patterns were recorded from each horse with a mean duration of 20 min. Since the method of intermittent observations does not give reliable information on the minor behaviour patterns (Hull et al., 1960) they will not be considered in detail.

7:3:3 Excretory behaviour

In the stalls the horses defaecated once per hour and urinated once every 4 hr 30 min (Table 39).

7:4 Discussion

Using body posture as a means of assessing wakefulness it was found that these horses were awake for only 72 per cent of the 24 hr as opposed to the 88 per cent found by Ruckebusch et al., (1970). However, since Ruckebusch used electrocorticography and electromyography it would seem that body posture may not be a reliable way of assessing sleep and wakefulness in the horse.

Ruckebusch et al., (1970) also reported that horses lie down for

TABLE 39

The frequency of excretions recorded from a group of horses between 16.45 hr and 08.45 hr

	Melody	Polly	Kirsty	Willow	Emma	Mean
Defaecations	16	17	19	10	18	16
Urinations	4	3	4	3	4	3.6

1 hr 59 min in each 24 hr period. However, the thoroughbred mares only lay down for an average of 45 min each during the 24 hr but this may have been a result of the cramped conditions in the stalls which did not allow the horses to lie on their sides and stretch their legs out straight while recumbent. Cattle only show paradoxical sleep when lying down and if recumbency is prevented at night the cattle adjust their paradoxical sleep to the daytime (Ruckebusch, 1975). These mares were not seen lying down in the field which suggests that conditions in the stalls had not deprived them of sleep at night. When the mares were turned out into the paddock at 08.45 hr they spent one or two minutes walking and cantering before settling down to eat hay but this was the only reaction they made to the freedom of the paddock after being restricted in the stalls for 16 hr.

The supply times, 08.45 hr and 16.45 hr, initiated the longest periods of eating hay and as the time from the 16.45 supply elapsed periods of eating hay were interspersed with rest periods which became longer towards the early morning. Figure 24 indicates that the horses ate hay at the same time and rested at the same time as each other particularly so when they were in the stalls: a finding which is similar to the report of Tyler (1972) who observed that members of a group of New Forest ponies rested at the same time and grazed at the same time as other members of the same group.

Unfortunately constraints on the experimenter prevented any detailed observations being made in addition to the intermittent

observations and therefore the results presented here give a picture of the main behaviour patterns, feeding and resting, of stalled horses without any further data on the minor behaviour patterns and their relation to feeding and resting behaviour.

8 THE BEHAVIOUR OF A GROUP OF HORSES DURING ONE 24 HR PERIOD IN EACH OF THE MONTHS JUNE, JULY AND AUGUST 1976

8.1 Introduction

In the literature on horse behaviour there is a lack of information on the maintenance behaviour of horses kept under farm conditions. There are no records of the behaviour patterns of domesticated horses over periods of 24 hours, and, considering the horse population and land usage by horses at grass in this country a better knowledge of the behaviour of horses in paddocks could help to improve paddock management. Observations over periods of 24 hours were considered to be essential to record the daily grazing habits of horses at grass and the horses' usage of the paddock taking into account the weather and the state of the pasture. Additional information could also be collected on maintenance and social behaviour patterns to make a comparison with free-ranging Equidae.

8:2 Materials and Methods

8:2:1 Subjects

The experimental group initially comprised of six horses; Gay, Flatspin, Kirsty, Dux, Passion and Albert. Another mare, Emma, was added to the group on 30th June 1976. She had given birth to a foal on 3rd April 1976 which subsequently died on 18th June 1976 and Emma was then stabled until 30th June 1976. On 20th June 1976 Dux was lame and was stabled until 30th June 1976. A month later she and Passion were sold and were removed from the group. The mares were weighed and teased for signs of oestrus once weekly and therefore were not observed on these days. All the mares except Flatspin were believed to be pregnant from the beginning of the experiment. However Flatspin was covered on 24th July 1976 and conceived at this service.

8:2:2 Pasture

The horses were kept in Field 1 which had been grazed by horses since May 1975 and had distinct roughs, lawns and paths. A map of Field 1 was drawn in May 1976 showing these three areas. Lawns included areas covered by herbage less than 5 cm tall, roughs were areas covered by herbage taller than 5 cm and paths were areas of bare soil. This delineation between lawns and roughs was used because herbage up to 5 cm tall appeared to have been grazed in contrast to the taller herbage. The map was overlaid with a grid which divided the paddock into 32 almost equal areas and in order to relate the area of the paddock to the map, posts in the fence were painted white at the points where the grid lines met the edge.

8:2:3 Observation periods

One 24 hr period was split into six intervals lasting 4 hr for each of the months June, July and August (Table 40).

8:2:4 Behaviour recordings

A cassette recorder was used for behaviour recordings. All observations during daylight were made from a seat 10ft high which was situated amongst the trees on one side of Field 1 where there was a clear view of the whole of the field. Behaviour patterns were recorded using the method of intermittent observations (Ewbank, 1967). Each horse's behaviour pattern was recorded at 5 min intervals during a 4 hr observation period and the horse's position in the field was plotted on a map.

The times of all defaecations and urinations seen during the observation periods were recorded and in addition certain behaviour patterns that occurred in sequence with some excretions were noted. These behaviour patterns were:

1) Approach: the horse walked a minimum of 5m before excreting
2) Leave: the horse walked a minimum of 5m after having excreted
3) Explore before: the horse sniffed the ground before excreting
4) Explore after: the horse sniffed the ground after having excreted.

In addition the places where the horses excreted were marked on the maps.

The social interactions recorded between the horses were:

1) Threat: an aggressive action made by a horse with its ears

TABLE 40 The dates and times of the observation periods

June		July		August	
Date	Time	Date	Time	Date	Time
21.6.76	16.00-20.00	21.7.76	14.00-18.00	10.8.76	09.00-13.00
22.6.76	12.00-16.00	22.7.76	10.00-14.00	11.8.76	13.00-17.00
25.6.76	20.00-00.00	26.7.76	18.00-22.00	19.8.76	01.00-05.00
27.6.76	00.00-04.00	28.7.76	06.00-10.00	19.8.76	05.00-09.00
28.6.76	04.00-08.00	28.7.76	22.00-02.00	19.8.76	21.00-01.00
29.6.76	08.00-12.00	29.7.76	02.00-06.00	23.8.76	17.00-21.00

back, which varied in intensity from a slight inclination of the head or a turning of the rump to a full bite or kick directed at another horse.

2) Approach: an approach by one horse to within 5m of another; if two or more horses were approached at once then the nearest horse was recorded as having been approached.

3) Follow: a follow was scored when one horse moved away from another and the second horse followed the first for more than 5m.

4) Leave: the departure of a horse from within 5m of another.

5) Submit: when a horse was either threatened, approached or followed, it might submit by turning its head away, stepping aside or running away usually with its ears turned ventro-laterally.

6) Mutual grooming: recordings were made of the horse that started and the horse that ended each incident of mutual grooming during the observation periods.

8:2:5 Non-behaviour recordings

8:2:5:1 Weather recordings

A recorder with a similar weather aspect to Field 1 was situated 90m from the field and was used to record temperature and humidity during June, July and August.

8:2:5:2 Plant species analysis

In May 1976 Field 1 was divided into eight rectangular sections of equal size and a foot-square quadrat was thrown ten times in each section. The herbage within the quadrat was cut to a height of 1 cm and the herbage from each section was then bulked to give eight samples which were frozen until February 1977 when they were

analysed for their content of different plant species.

8:2:5:3 Herbage analysis

Herbage samples were collected from Field 1 on 9th June 1976, 23rd June 1976, 7th July 1976, 23rd July 1976, 4th August 1976 and 27th August 1976. The field was divided into 16 rectangular sections and a foot-square quadrant was thrown eight times in each section. The herbage within the quadrant was cut to a height of 1 cm and bulked for each section, giving a total of 16 samples from the paddock. The samples were weighed, dried at 240°F for 48 hours, reweighed, milled and then each set of 16 samples that had been taken on the same day was bulked to give a total of six samples for chemical analysis using the procedure given in Appendix 14:1.

8:2:5:4 Faeces analysis

Faeces were collected from the horses when they were voided at times out-with the observation periods. The faeces were weighed, dried at 240°F for 48 hr, reweighed and the samples from the first and second week, and from the third and fourth week of June, July, and August were bulked to give a total of six samples for chemical analysis using the procedure given in Appendix 14:1.

8:2:5:5 The area of the paddock covered by roughs, lawns and paths

This was measured by cutting out the printed map and weighing it. The weight of the map, Y g, represented the area of the paddock, 12 730m^2, therefore 1 g of paper represented 12 730 ÷

Ym^2. The three areas - roughs, lawns and paths - were cut out from the map and weighed separately giving values of Rg, Lg and Pg respectively. The area in m^2 of roughs (lawns or paths) was then calculated as (12 730 - Y) x R (L or P) m^2. Ten maps were cut in pieces and weighed and the mean weights were used for the calculation of the three areas (Appendix 14:2).

8:2:5:6 Statistical analysis

The method used to define a nursing bout (Section 5:2:5) was applied to the data recorded here to define a 'meal'.

A paired 'Student's' t-test (Bailey, 1975) was used to test for the significance of differences in the following:

1) The duration of grazing, resting and 'other' behaviour between June, July and August.

2) The frequency and duration of 'meals' between June, July and August.

3) The frequency and duration of rests between June, July and August.

All calculations involving time have been corrected to the nearest 5 min.

To investigate whether the horses were behaving either independently of one another or as a group then the expected numbers of horses grazing or resting at the 5 min intervals would have to be compared with the observed numbers. If observations could be considered as independent events - as in tossing a coin - then the expected frequency of seven horses grazing at the same time could be

calculated on the assumption that the horses were acting independently of their behaviour in preceding and succeeding intervals. To investigate whether or not observations were independent events, the distribution of runs of grazing and resting behaviour was analysed to see if it supported this hypothesis (Wilks, 1962). If the observations were independent events then the observed number of runs of a behaviour pattern would be equal to the expected number $\pm$ 2 SD, a run being a series of consecutive observations of the same behaviour pattern from one horse (Appendix 14:3).

A two-tailed t-test (Snedecor and Cochran, 1967) was used to test for the significance of differences between the time that horses spent grazing the lawns (or roughs) and the proportion of field covered by lawns (or roughs) (Appendix 14:4).

Analysis of variance (Snedecor and Cochran, 1967) was used to test for the significance of differences between mares and juveniles in the time they spent grazing lawns or roughs (Appendix 14:6).

The mean distance between two horses was calculated by converting the mean distance between the map plottings of each pair of horses to metres.

8:3 Results

8:3:1 The time spent in each behaviour pattern during one period of 24 hr

8:3:1:1 Grazing

The mean grazing time during 24 hr in July was significantly less than that in June ($p \leqslant 0.05$) and in August ($p \leqslant 0.05$). However there was no significant difference between the mean grazing times of June and August (Table 41).

8:3:1:2 Resting

In July the horses rested for longer than in June ($p \leqslant 0.001$) and August ($p \leqslant 0.001$) but the times spent resting in June and August did not differ significantly (Table 41).

8:3:1:3 'Other' behaviour patterns

Ten behaviour patterns were recorded in addition to resting and grazing behaviour and these have been grouped as 'other' behaviour patterns.

In June the horses spent more time in 'other' behaviour patterns than in July ($p \leqslant 0.01$) and August ($p \leqslant 0.05$) but the scores for July and August were similar (Table 41).

Walking behaviour made up 60% of 'other' time in June, 55% in July and 62% in August, while standing still was 23% of 'other' time in June, 20% in July and 25% in August. The remaining eight behaviour patterns, grouped as 'trace' behaviour patterns in Table 42, were grooming, drinking, exploring, excreting, social interactions,

TABLE 41 The time (hr) each animal spent grazing, resting, or in 'other' behaviour patterns during one period of 24 hr in each of the months of June, July and August 1976

		Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	Grazing	-	16.5	16.2	16.5	-	17.4	16.7	16.7	0.2
	Resting	-	04.2	04.6	04.5	-	02.9	03.3	03.9	0.3
	Other	-	03.2	03.2	03.0	-	03.7	03.9	03.4	0.2
JULY	Grazing	15.1	13.9	13.7	16.3	15.5	16.5	15.9	15.3	0.4
	Resting	07.8	08.5	08.2	06.9	07.2	06.3	06.4	07.3	0.3
	Other	01.1	01.6	02.1	00.7	01.3	01.2	01.7	01.4	0.2
AUGUST	Grazing	18.1	16.6	16.0	17.4	-	-	16.2	16.9	0.4
	Resting	04.6	05.4	05.7	04.0	-	-	04.5	04.8	0.3
	Other	01.3	02.0	02.2	02.6	-	-	03.3	02.3	0.3

TABLE 42 The time (min) each animal spent in walking, standing and 'trace' behaviour patterns during one period of 24 hr in each of the months of June, July and August 1976

		Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	Walking	-	115	115	135	-	125	115	120	5
	Standing	-	45	45	45	-	50	50	50	0
	'Trace'	-	35	25	0	-	45	70	35	10
JULY	Walking	25	60	60	40	60	45	30	45	5
	Standing	25	15	30	0	10	10	25	15	5.
	'Trace'	15	20	35	5	10	15	45	20	5
AUGUST	Walking	65	55	50	105	-	-	150	85	20
	Standing	15	40	60	20	-	-	35	35	10
	'Trace'	0	20	25	30	-	-	15	20	5

licking the soil, cantering, and showing the oestrous posture. Each of these behaviour patterns was scored for 30 min or less from each horse during one 24 hr period and since the method of intermittent observation does not give reliable information on the minor behaviour patterns (Hull et al., 1960) they will not be considered separately.

8:3:2 The diurnal distribution of behaviour patterns

The horses tended to graze and rest at the same time as one another (Figure 25). However, grazing and resting behaviour consistently occurred in fewer than the expected number of runs (Table 43, Appendix 14:3). This indicated that the observations of grazing and resting behaviour were not independent events and it was not possible to investigate whether the horses were behaving either independently of one another or as a group.

8:3:2:1 Grazing behaviour and 'meals'

Runs of grazing behaviour, as shown in Figure 25, were interspersed with intervals lasting between 5 and 130 min. During the shorter intervals of 5 to 20 min the horses usually showed one or more of the 'other' behaviour patterns or occasionally they rested; however, during intervals of 25 min or longer the horses always rested for all or part of the time. Figure 26 shows that intervals of 5 min in grazing behaviour occurred more often than intervals of 10 min or more and that they accounted for 61% of all the intervals between runs of grazing behaviour. In addition the negative exponential curve derived from intervals in grazing behaviour (Figure 27) shows a change in slope between intervals

TABLE 43 The means of the observed and the expected number of runs of grazing, resting and 'other' behaviour patterns shown by a group of horses during one period of 24 hr in each of the months June, July and August, 1976

		Grazing	Resting	'Other'
JUNE	Observed	37	11	34
	Expected	62	39	35
	S.D.	3.61	2.29	2.04
JULY	Observed	18	9	14
	Expected	67	61	16
	S.D.	3.91	3.58	0.89
AUGUST	Observed	23	8	23
	Expected	61	47	25
	S.D.	3.54	2.71	1.42

of 5 min and 10 min in duration. As a result of this, for the purposes of this experiment, a meal was defined as 'A period of grazing behaviour delimited by intervals of non-grazing behaviour lasting 10 min or longer'. Interruptions of 5 min in grazing behaviour were therefore intra-meal intervals while those longer than 5 min were inter-meal intervals. Meals varied in duration and frequency between horses and between months (Table 44). In June each horse made an average of 12 meals per 24 hr lasting 100 min each, compared with 9 meals in July lasting 115 min, and 9 meals of 120 min in August. However neither the frequency of meals nor their mean length differed significantly between the months.

8:3:2:1:1 Grazing behaviour in June

The two geldings, Passion and Albert, had fewer but longer meals than the mares (Table 44). Passion had the longest meal, lasting 640 min, which started at 13.20 hr and ended at 24.00 hr and it was between these times that all the horses in the group had their longest meal. Grazing behaviour occurred almost continuously during two major periods (Figure 25) from 10.50 hr to 24.00 hr, and from 03.00 hr to 07.20 hr. Between 24.00 hr and 0300 hr, and between 07.20 hr and 10.50 hr shorter meals alternated with the major rest periods.

8:3:2:1:2 Grazing behaviour in July

Flatspin had the most meals in July, 12, with a mean length of 75 min, while Kirsty had the least number, 6, each lasting 170 min (Table 44). Kirsty also had the longest meal lasting 375 min, which

TABLE 44 The frequency, duration of the shortest and longest meal and the mean duration (min) of meals recorded from a group of horses during one period of 24 hr in each of the months June, July and August 1976

		Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	Frequency	-	13	13	15	-	9	9	12	1
	Shortest meal	-	5	5	5	-	10	15	8	5
	Longest meal	-	360	450	225	-	640	350	405	70
	Mean length	-	85	85	70	-	135	125	100	15
JULY	Frequency	9	9	12	6	10	8	8	9	1
	Shortest meal	25	30	5	65	5	5	5	20	10
	Longest meal	275	320	300	375	340	275	340	320	15
	Mean length	100	100	75	170	100	130	130	115	10
AUGUST	Frequency	8	8	9	9	-	-	11	9	1
	Shortest meal	10	10	5	5	-	-	5	5	0
	Longest meal	345	270	295	275	-	-	350	305	15
	Mean length	140	130	115	130	-	-	95	120	10

began at 17.30 hr and ended at 23.40 hr and it was between these times that all the horses had their longest meal.

There were six periods during the day when the horses grazed for the majority of the time; these periods which alternated with major rest periods were from 17.30 hr to 23.40 hr, 03.50 hr to 08.00 hr, 09.40 hr to 11.40 hr, 12.50 hr to 14.50 hr, 15.25 hr to 16.45 hr and 24.55 hr to 02.20 hr (Figure 25).

8:3:2:1:3 Grazing behaviour in August

Albert had 11 meals in August with a mean length of 95 min compared with the mares' mean of 8.5 meals lasting 130 min each (Table 44). Albert also had the longest meal of 350 min which began at 16.50 hr and ended at 22.40 hr. Three mares had their longest meal between these times while Gay's longest meal started at 03.45 hr and ended at 08.15 hr.

The group grazed in five periods during the day; these were from 17.00 hr to 22.40 hr, 03.50 hr to 08.15 hr, 09.45 hr to 13.45 hr, 23.45 hr to 02.20 hr and from 14.30 hr to 15.50 hr (Figure 25). Again these grazing periods alternated with the major rest periods.

8:3:2:2 Resting behaviour

Resting behaviour occurred in runs which varied in length from a minimum of 5 min to a maximum of 120 min. Furthermore the horses tended to rest at the same time as one another and the nocturnal rests occurred at a similar time each month (Figure 25).

In June the animals had an average of 11 rests each lasting 20 min compared with 9 rests lasting 55 min in July and 8 rests of 35 min in August (Table 45). The frequency of rests each month was not significantly different but the mean duration of rests was greater in July than in June ($p \leqslant 0.001$) or in August ($p \leqslant 0.05$) and in August the mean duration of rests was greater than in June ($p \leqslant 0.01$).

During the hours of darkness there were two major rest periods and the horses spent a larger proportion of their rest time during the night than the proportion of 24 hr made up by the hours of darkness (Table 46).

8:3:2:2:1 Resting behaviour in June

There were five major rest periods in June; three of these occurred during the night and the other two were between 07.00 hr and 11.00 hr. Some short rests occurred during daylight hours (Figure 25).

The mean time that each horse spent in recumbency per 24 hr was 55 min or 23% of the total resting time. Flatspin lay down only once for 10 min while Albert lay down five times for a total of 95 min. Albert also spent the longest time lying continually, 65 min, from 01.55 hr until 03.00 hr (Table 45).

The majority of the time spent in recumbency occurred during the 01.40 hr rest period but there were never more than four horses lying down simultaneously.

TABLE 45 The frequency, duration of the shortest and longest rest, the mean duration of rests and the time spent lying down (min) shown by a group of horses over one period of 24 hr in each of the months June, July and August 1976

		Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	Frequency	-	11	13	13	-	9	8	11	1
	Shortest rest	-	5	5	5	-	5	5	5	0
	Longest rest	-	80	80	45	-	45	80	65	10
	Mean length	-	25	20	20	-	20	25	20	0
	Lying down	-	65	10	25	-	80	95	55	15
JULY	Frequency	7	10	13	9	9	6	7	9	2
	Shortest rest	5	5	5	5	10	10	5	5	0
	Longest rest	120	105	95	100	90	90	95	100	5
	Mean length	65	50	40	45	50	65	55	55	5
	Lying down	210	180	55	70	190	235	210	165	30
AUGUST	Frequency	8	8	9	8	-	-	8	8	0
	Shortest rest	10	5	5	5	-	-	5	5	0
	Longest rest	75	80	80	70	-	-	75	75	0
	Mean length	35	40	40	30	-	-	35	35	0
	Lying down	40	95	0	0	-	-	105	50	20

TABLE 46

The hours of darkness, expressed as a percentage of 24 hr, and the mean time spent resting during the hours of darkness, expressed as a percentage of total resting time, during one 24 hr period in each of the months of June, July and August 1976

	Hours of darkness	Rest during darkness
June	12%	45%
July	29%	41%
August	31%	46%

8:3:2:2:2 Resting behaviour in July

There were six major rest periods in July; two of these occurred during the hours of darkness and four were recorded between 08.00 hr and 17.35 hr. Five of the horses rested for some of the time between 05.00 hr and 06.50 hr and there were a few rests lasting 5 min at 13.30 hr and 18.00 hr (Figure 25).

Each horse spent an average of 165 min per 24 hr in recumbency, this being 37% of their total resting time. Individual differences were found; Kirsty lay down only once while Dux lay down six times. Again Albert spent the longest time lying down continually, 95 min, from 02.20 hr to 03.55 hr (Table 45). However it is not known whether these were genuine differences or a result of recording periods having been made on different days. Most of the time spent lying down occurred during the 02.20 hr rest period and for 15 min of this time all seven horses were lying down together.

8:3:2:2:3 Resting behaviour in August

There were five major rest periods in August; two of these occurred at night while the other three were between 08.00 hr and 17.15 hr. Kirsty and Flatspin each had a short rest at 12.05 hr and 13.00 hr respectively (Figure 25). The mean time per 24 hr that each horse spent in recumbency was 50 min and this was 16% of their total resting time. Kirsty and Flatspin did not lie down at all, but Albert lay down four times for a total of 105 min. Albert and Gay both spent the longest time lying continually, 45 min, from 09.00 hr to 09.45 hr (Table 45). Never

more than three horses were seen lying down at once.

8:3:2:2:4 Places in the field where the horses rested

Sixteen major rest periods were recorded during the 72 hr of observations and ten of these rests occurred at point A (Figure 28). One major rest period was recorded at each of the points A to G. In addition short rests were recorded at all the points A to G and at the points X.

8:3:2:3 'Other' behaviour patterns

The horses did not maintain any behaviour pattern apart from grazing or resting for more than 20 minutes. A total of 376 runs of 'other' behaviour were recorded during the 72 hr of observations; 324 of these lasted for 5 min, 35 for 10 min, 12 for 15 min and 5 for 20 min. Runs between 10 min and 20 min in duration usually consisted of two or more of the 'other' behaviour patterns. The 'other' behaviour patterns were evenly distributed over each 24 hr period, usually occurring as an interruption in grazing behaviour or between grazing and resting behaviour, but rarely between two rests.

8:3:3 Excretory behaviour

The horses defaecated and urinated more often in June than in July or August (Table 47). The mean frequency of defaecations per 24 hr was 12 for males and 11 for females while the urination frequencies were 8 for males and 7 for females.

The majority of excretions, 97%, were on roughs. However nine

TABLE 47 The number of defaecations (d) and urinations (u) shown by each horses during one period of 24 hr in each of the months June, July and August 1976

		Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	d	-	13	13	19	-	15	12	14	1
	u	-	7	11	7	-	10	8	9	1
JULY	d	11	10	12	9	8	12	10	10	1
	u	2	5	9	6	7	6	9	6	1
AUGUST	d	11	10	12	9	-	-	12	11	1
	u	6	7	8	4	-	-	8	7	1

excretions were on lawns of which six were from females and three from males (Table 48).

The two male juveniles 'approached', 'left', 'explored before' and 'explored after' excreting almost twice as often as the females. 'Approach' and 'leave' were recorded more often than 'explore before' and 'explore after' for both the males and the females (Table 49).

8:3:4 The time spent on the roughs, lawns and paths

The number of map plottings on roughs, lawns and paths were expressed as a percentage of the total number of map plottings each month (since maps were only used during daylight hours these totals were 252 in June, 204 in July and 192 in August). These values were then compared to the proportion of paddock covered by each area (Table 50). In June the horses spent longer on the lawns and less time on the roughs compared with the proportion of paddock these areas covered. The time on paths was proportional to the area of paths. However the juveniles spent more time on the lawns than the mares and less time on the roughs. In July the mares and juveniles again spent longer on the lawns than would have occurred if they had moved about the field at random. The juveniles spent a similar time on the two areas to that recorded in June while the mares spent less time on the lawns and more on the roughs than they had in June. In August the mares spent 29% of the day on lawns and 57% on roughs; values similar to the proportion of paddock covered by these areas. However, the only juvenile present in August spent 70% of the day on lawns and 17%

TABLE 48

The number of defaecations (d) and urinations (u) on lawns and roughs during one 24 hr period in each of the months June, July and August 1976

		Lawns	Roughs	Total
JUNE	d	0	72	72
	u	0	43	43
JULY	d	5	67	72
	u	0	44	44
AUGUST	d	3	51	54
	u	1	32	33

TABLE 49 The number of times that Approach, Leave, Explore before and Explore after were recorded, expressed as a percentage of the total number of defaecations and urinations recorded from male and female horses during three 24 hr periods

	No. of defaecations	Approach	Leave	Explore before	Explore After
Female	137	32	41	5	7
Male	61	66	61	15	25
	No. of urinations				
Female	80	28	63	3	16
Male	40	58	65	15	23

on roughs (Table 50). Time spent on the paths was greater in July and August than in June.

8:3:4:1 The time spent on the roughs, lawns and paths when grazing

When the horses were grazing they spent a negligible amount of time on the paths (Table 51). In June they spent more time grazing the lawns than they would if they grazed the paddock at random. The juveniles grazed the lawns significantly more than the roughs in June, July and August ($p \leqslant 0.05$). The mares however grazed the lawns for less time in July than they did in June and in August the mares' grazing time on the lawns and roughs was similar to the proportion of the paddock covered by these areas (Table 51 and 52, Appendix 14.4).

The difference between the mares and the juveniles in the time that they spent grazing the lawns and roughs was significant each month (Table 53; Appendix 14:5).

8:3:5 The distances travelled in the paddock

In June the horses travelled further than in July ($p \leqslant 0.001$) or in August ($p \leqslant 0.001$) while in August the horses travelled further than in July ($p \leqslant 0.001$). The juveniles however travelled further than the mares each month (Table 54).

8:3:6 Social interactions

A total of 1 165 interactions were recorded from five horses in June compared with only 565 from seven horses in July and 589 from

TABLE 50 The percentage of the field covered by roughs, lawns and paths and the time each animal spent on each area - expressed as a percentage of daylight hours - during the daylight hours of one 24 hr period in each of the months of June, July and August 1976

			MARES						JUVENILES				
		% of field	Emma	Gay	Flatspin	Kirsty	Mean	S.E.M.	Dux	Passion	Albert	Mean	S.E.M.
JUNE	Roughs	63	-	39.7	41.3	40.9	40.6	0.5	-	32.1	25.4	28.7	2.7
	Lawns	33	-	57.1	56.7	54.8	56.2	0.7	-	66.3	69.0	67.6	1.4
	Paths	4	-	3.2	2.0	4.4	3.2	0.7	-	1.6	5.5	3.5	1.9
JULY	Roughs	63	31.4	47.1	49.0	55.4	45.7	5	28.9	37.3	23.0	29.7	4.1
	Lawns	33	55.4	40.2	39.2	41.2	44.0	3.8	62.7	58.3	66.7	62.6	2.4
	Paths	4	13.2	12.7	11.8	3.4	10.3	2.3	8.3	4.4	10.3	7.7	1.7
AUGUST	Roughs	63	59.9	53.1	56.8	56.2	56.5	1.4	-	-	17.2	17.2	-
	Lawns	33	27.1	31.3	28.1	27.6	28.5	0.9	-	-	70.3	70.3	-
	Paths	4	13.0	15.6	15.1	16.2	15.0	0.7	-	-	12.5	12.5	-

TABLE 51 The percentage of the field covered by roughs, lawns, and paths and the time the horses spent grazing each area during the daylight hours of one 24 hr period in each of the months June, July and August, 1976

Grazing time is expressed as: $\frac{\text{time spent grazing the roughs (lawns or paths)}}{\text{total grazing time during daylight hours}} \times 100\%$

		MARES						JUVENILES				
	% Area	Emma	Gay	Flatspin	Kirsty	Mean	S.E.M.	Dux	Passion	Albert	Mean	S.E.M.
Roughs	63	-	42.2	42.4	45.6	43.4	1.1	-	27.9	23.1	25.5	2.4
Lawns	33	-	57.8	57.6	53.3	56.2	2.5	-	72.1	76.5	74.3	2.2
Paths	4	-	0	0	1.1	0.4	0.4	-	0	0.5	0.2	0.2
Roughs	63	27.4	49.2	53.8	58.8	47.3	6.9	14.4	24.0	16.2	18.2	2.9
Lawns	33	72.6	50.8	46.2	41.2	52.7	6.9	84.2	75.3	81.7	80.4	3.7
Paths	4	0	0	0	0	0	0.0	1.4	0.7	2.0	1.4	0.4
Roughs	63	66.0	60.1	62.8	66.7	63.9	1.5	-	-	9.3	9.3	-
Lawns	33	33.3	39.1	37.2	32.7	35.6	1.5	-	-	89.3	89.3	-
Paths	4	0.7	0.7	0	0.7	0.7	0.0	-	-	1.4	1.4	-

TABLE 52 A comparison between the time that horses spent grazing the lawns (l) and roughs (r), and the proportion of field covered by lawns and roughs

$$\text{Mean } (l - r) = \sum \left[\frac{\text{grazing time on l in daylight}}{\text{total grazing time in daylight}} \times 100 - \frac{\text{grazing time on r in daylight}}{\text{total grazing time in daylight}} \times 100 \right] \div n$$

	MARES				JUVENILES			
	n	mean (l-r)	t	p	n	mean (l-r)	t	p
JUNE	3	12.8	16.5693	***	2	48.8	24.8847	***
JULY	4	5.4	3.1801	*	3	62.2	7.1730	**
AUGUST	4	-28.3	0.5475	N.S.	1	80.0	17.9755	***

TABLE 53 A comparison between mares and juveniles in the time they spent grazing lawns (l) and roughs (r) during the daylight hours of one 24 hr period in each of the months June, July and August 1976

$$\text{Mean } (l - r) = \sum \left[\frac{\text{grazing time on l in daylight}}{\text{total grazing time in daylight}} \times 100 - \frac{\text{grazing time on r in daylight}}{\text{total grazing time in daylight}} \times 100 \right] \div n$$

	MARES		JUVENILES			
	n	mean (l-r)	n	mean (l-r)	F ratio	p
JUNE	3	12.8	2	48.8	77.3720	**
JULY	4	5.4	3	62.2	11.1583	*
AUGUST	4	-28.3	1	80.0	250.6774	***

TABLE 54 The minimum distance (m) travelled by a group of horses during one 24 hr period in each of the months June, July and August, 1976

	Emma	Gay	Flatspin	Kirsty	Dux	Passion	Albert	Mean	S.E.M.
JUNE	-	6 300	6 500	6 500	-	7 050	7 150	6 700	170
JULY	3 500	3 350	3 900	3 550	4 400	4 600	4 800	4 000	220
AUGUST	4 200	4 250	4 600	4 600	-	-	5 450	4 600	220

five horses in August. There was a total of 259 threats, 719 approaches, 316 follows, 438 leaves and 587 submissions (Tables 55, 56 and 57).

Mare-to-mare interaction and juvenile-to-juvenile interactions occurred more often than interactions between mares and juveniles. On average, during one 24 hr period, each mare had 38 interactions with other mares and 15 interactions with juveniles while each juvenile had 52 interactions with other juveniles and 19 interactions with mares.

Interactions often occurred in a quick sequence. For example:

1) Gay threatened Flatspin.
2) Flatspin submitted to Gay.
3) Flatspin threatened Kirsty.
4) Kirsty submitted to Flatspin.
5) Flatspin followed Kirsty.

The majority of interactions lasted for 1 to 2 sec each. Threats to bite were more common than Threats to kick and most of the Threats to bite were just a slight inclination of the head with the ears back towards the threatened horse. Usually a horse submitted by taking a few steps away from the threatening horse. Sometimes however a horse would deliver two or three threats in quick succession to the same horse which submitted to all but the last threat by stepping away. Generally the last threat, of greater intensity than the first, usually caused the threatened horse to trot or canter from the aggressive animal.

Kirsty was more aggressive towards the juveniles than were the other mares and often followed up threats to bite by chasing the young horse away.

Two horses were sometimes seen to sniff each other on the nose, neck or flank and this often happened when one horse approached another, or when two horses were grazing close by. Flatspin was showing the oestrous posture on 22nd June 1976 and spent most of this observation period near Passion. At frequent intervals they smelt each other and several times Flatspin stood in the oestrous posture in front of, or beside, Passion.

No vocalisations from the horses were heard during observation periods.

8:3:6:1 Social interactions in June

A linear hierarchy was apparent in the group in the order, from top to bottom, of Gay, Flatspin, Kirsty, Passion and Albert. Each horse only threatened horses below it and submitted to horses above it in the hierarchy with four exceptions. The exceptions were two threats from Kirsty to Gay, and one threat from Passion to Gay, and one submission by Gay to Flatspin. The horses approached, followed and left the horses adjacent in the hierarchy most often (Table 55).

8:3:6:2 Social interactions in July

The linear hierarchy in the group was less consistent than that in June. The order, from top to bottom, was Emma, Gay, Flatspin,

TABLE 55 The social interactions recorded in a group of horses during one 24 hr period in June 1976: the frequency with which horse 1 interacted with horse 2

Horse 1	Gay				Flatspin				Kirsty				Passion				Albert			
Horse 2	F	K	P	A	G	K	P	A	G	F	P	A	G	F	K	A	G	F	K	P
Threat	11	7	11	4	0	9	6	4	2	0	15	16	1	0	0	3	0	0	0	3
Approach	63	33	19	9	6	45	13	5	5	8	15	10	4	9	6	84	7	9	12	14
Follow	36	6	5	0	15	31	8	0	8	18	3	1	10	3	4	31	3	1	1	16
Leave	14	8	3	3	21	15	4	3	17	20	3	2	5	4	1	15	5	5	6	25
Submit	1	0	0	0	54	0	0	0	36	52	0	0	23	18	26	0	11	8	18	71

G = Gay
F = Flatspin
K = Kirsty
P = Passion
A = Albert

Kirsty, Passion, Dux, Albert. The horses threatened those below them, and submitted to those above them in the hierarchy with the following exceptions: Emma did not threaten Kirsty, Passion did not threaten Dux and Dux did not threaten Albert. However Kirsty, Dux and Albert submitted when approached by Emma, Passion and Dux respectively and Dux submitted once when approached by Albert.

As in June the horses approached, followed and left the horses adjacent in the hierarchy most often (Table 56).

8:3:6:3 Social interactions in August

The hierarchy in the group was very similar to that in July: Emma, Gay, Flatspin, Kirsty, Albert, but behaviour was very consistent and each horse only threatened the horses below it and submitted to the horses above it in the hierarchy with no exceptions. Approaches, follows and leaves were scored more often between two mares than between Albert and a mare (Table 57).

8:3:6:4 Social Behaviour and Leadership

The horses which appeared to initiate a change in behaviour pattern amongst the group were not usually the dominant horses. Kirsty Albert or Flatspin were often the first horses to stop grazing and rest, to start grazing after resting, or to walk to the water trough, and were often followed by the other horses within 5 or 10 min. The order in which the horses drank from the trough was usually in the order of dominance. If, for example, Albert was drinking and Gay arrived at the trough Albert would step aside while Gay drank. Horses waiting to drink stood 2 to 5 m from the trough.

TABLE 56 The social interactions in a group of horses during one 24 hr period in July: the frequency with which horse 1 interacted with horse 2

Horse 1	Emma						Gay						Flatspin						Kirsty					
Horse 2	G	F	K	P	D	A	E	F	K	P	D	A	E	G	K	P	D	A	E	G	F	P	D	A
Threat	3	1	0	2	2	2	0	3	1	3	4	3	0	0	3	3	4	4	0	0	0	4	8	6
Approach	2	4	1	8	4	3	2	5	4	7	4	4	5	5	6	2	1	4	1	6	5	3	2	2
Follow	0	1	2	1	0	0	0	4	2	1	0	0	0	5	2	3	0	1	0	2	2	0	0	0
Leave	4	4	3	4	3	3	1	6	3	1	1	1	6	10	5	2	3	2	3	7	5	2	2	2
Submit	0	0	0	0	0	0	4	0	0	0	0	0	3	3	0	0	0	0	1	5	8	0	0	0

E = Emma
G = Gay
F = Flatspin
K = Kirsty
P = Passion
D = Dux
A = Albert

(cont.)

TABLE 56 (cont.)

Horse 1	Passion						Dux						Albert					
Horse 2	E	G	F	K	D	A	E	G	F	K	P	A	E	G	F	K	P	D
Threat	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Approach	2	2	2	2	8	21	6	3	5	3	7	10	3	4	4	2	5	7
Follow	0	0	0	0	2	14	0	0	1	0	0	8	0	0	0	0	2	1
Leave	3	1	2	1	3	4	0	0	2	0	1	0	7	3	3	4	16	11
Submit	7	8	4	5	0	0	5	6	4	9	4	1	4	3	6	7	20	3

E = Emma
G = Gay
F = Flatspin
K = Kirsty
P = Passion
D = Dux
A = Albert

TABLE 57 The social interactions in a group of horses during one 24 hr period in August: the frequency with which horse 1 interacted with horse 2

Horse 1	Emma				Gay				Flatspin				Kirsty				Albert			
Horse 2	G	F	K	A	E	F	K	A	E	G	K	A	E	G	F	A	E	G	F	K
Threat	14	13	16	4	0	2	14	8	0	0	14	7	0	0	0	14	0	0	0	0
Approach	16	14	5	2	7	15	13	2	1	15	13	3	4	7	6	6	8	11	6	3
Follow	3	5	0	0	4	5	3	0	3	22	9	0	0	1	1	1	2	1	1	1
Leave	12	8	3	6	3	20	3	1	3	12	6	2	7	11	8	1	2	3	2	2
Submit	0	0	0	0	20	0	0	0	17	6	0	0	16	25	23	0	3	11	10	18

E = Emma
G = Gay
F = Flatspin
K = Kirsty
A = Albert

Gay and Flatspin, and sometimes Passion and Albert, drank from the trough together although usually only one horse drank at a time. When a horse had finished drinking it moved away from the trough to graze or rest.

If a horse rolled then one or two other horses sometimes rolled within a few minutes.

8:3:6:5 Incidents of mutual grooming

When a horse started an incident of mutual grooming it approached another horse 'head-on' with its ears forward or set ventro-laterally and with a non-aggressive facial expression. It then usually sniffed the other horse's neck and then started grooming on the neck or withers and worked back to the rump also grooming the shoulder and the side of the rump. The other horse usually paused for one or two seconds before starting to mutual groom. In all but one of the incidents observed a dominant horse started grooming a subordinate horse. At times, the subordinate horse moved away within a few seconds and the dominant horse would then either follow it and start mutual grooming again or approach another horse to groom mutually. An incident was ended when a horse stopped grooming and stepped aside from the other horse. Often when the dominant horse ended the incident it would threaten the subordinate horse which then moved away.

Seventy-three incidents of mutual grooming were observed (Table 58); most of these lasted between 1 and 2 min but the shortest incidents were a few seconds long. However, one incident between

TABLE 58 The number of incidents of mutual grooming between horses 1 and 2: a) started by horse 1 and b) ended by horse 1, during one 24 hr period in each of the months June, July and August

			HORSE 2						
			Emma	Gay	Flatspin	Kirsty	Passion	Dux	Albert
HORSE 1	Emma	a	-	1	-	-	-	-	1
		b	-	-	-	-	-	-	1
	Gay	a	-	-	49	6	-	-	-
		b	1	-	6	1	-	-	-
	Flatspin	a	-	-	-	-	-	-	-
		b	-	43	-	-	-	-	-
	Kirsty	a	-	-	-	-	-	-	-
		b	-	5	-	-	-	-	-
	Passion	a	-	-	-	-	-	1	14
		b	-	-	-	-	-	1	1
	Dux	a	-	-	-	-	-	-	-
		b	-	-	-	-	-	-	-
	Albert	a	-	-	-	-	1	-	-
		b	-	-	-	-	14	-	-

Passion and Albert lasted for more than 15 min. Only a limited number of pairs of horses indulged in this behaviour; Emma groomed Gay and Albert once, Gay groomed Flatspin 49 times and Kirsty six times, Passion and Albert mutual groomed 15 times and Passion and Dux groomed once. Mutual grooming was started by the dominant horse in 72 cases and ended by the subordinate animal in 63 cases. There was only one incident of a mare, Emma, grooming mutually with a juvenile, Albert.

8:3:7 Distances between the horses

In June, there was a direct relationship between the mean distance between two animals and their proximity in the hierarchy (Table 59). Flatspin had the shortest distance to Gay and Kirsty, and was furthest from Albert. Albert, on the other hand, was kept almost 30m from all three mares but only 13m from Passion. In July the distances were less consistent with the hierarchy and were larger than in June (Table 59). Dux tended to be nearer to the mares than to Passion, and Albert again kept the largest distances between himself and each of the mares. All the distances between mares were less than the distances between mares and juveniles. In August the mean distances between Albert and the mares were 25m or greater while the mean distance between each pair of mares was not more than 22m and was directly related to their proximity in the hierarchy (Table 59).

The distance between two horses was less when both horses were resting than when they were active: in many cases it was less than half of the average distance. Also, when resting, the horses

TABLE 59

The mean distance (m) between each pair of horses recorded during the daylight hours of one 24 hr period in each of the months June, July and August 1976

JUNE

	Gay	Flatspin	Kirsty	Passion	Albert
Gay	-	10	13	19	30
Flatspin		-	10	20	29
Kirsty			-	21	32
Passion				-	13
Albert					-

JULY

	Emma	Gay	Flatspin	Kirsty	Passion	Dux	Albert
Emma	-	23	21	25	31	22	37
Gay		-	17	19	32	24	38
Flatspin			-	17	28	24	34
Kirsty				-	28	25	37
Passion					-	23	25
Dux						-	31
Albert							-

TABLE 59 (cont.)

AUGUST

	Emma	Gay	Flatspin	Kirsty	Albert
Emma	-	12	15	22	27
Gay		-	10	21	25
Flatspin			-	18	30
Kirsty				-	32
Albert					-

did not always keep a greater distance between themselves and the horses further away in the hierarchy (Table 60). In June the mean distance of 24m between Albert and Passion, recorded when both animals were resting, was greater than the average distance of 13m but this was biased by one rest lasting 40 min when they were 30m apart.

8:3:8 Weather recordings

The mean maximum and minimum temperatures and the mean relative humidity for the days on which observations were made are shown in Table 61.

8:3:9 Plant species analysis

The composition of the sward in May 1976 was as follows:

1)	Perennial ryegrass	64%
2)	Cocksfoot	11%
3)	Dicotyledons	10%
4)	Rough stalked meadowgrass	7%
5)	Annual meadowgrass	4%
6)	White clover	3%
7)	Red clover	1%
8)	Italian ryegrass	trace
9)	Couch grass	trace

8:3:10 Herbage analysis

The herbage yield from Field 1 decreased steadily from 9th June 1976 to 27th August 1976 (Figure 29). However the moisture content of each of the herbage samples varied: the wettest and the driest

TABLE 60

The mean distances (m) between each pair of horses when both horses in the pair were resting, recorded during the daylight hours of one 24 hr period in each of the months June, July and August 1976

JUNE

	Gay	Flatspin	Kirsty	Passion	Albert
Gay	-	7	5	10	18
Flatspin	-	-	6	11	19
Kirsty			-	11	23
Passion				-	24
Albert					-

JULY

	Emma	Gay	Flatspin	Kirsty	Passion	Dux	Albert
Emma	-	5	6	10	9	8	6
Gay		-	5	9	10	7	7
Flatspin			-	8	9	10	8
Kirsty				-	10	11	11
Passion					-	5	9
Dux						-	9
Albert							-

TABLE 60 (cont.)

AUGUST

	Emma	Gay	Flatspin	Kirsty	Albert
Emma	-	6	6	7	8
Gay		-	3	7	5
Flatspin			-	8	6
Kirsty				-	11
Albert					-

TABLE 61

The average maximum and minimum temperatures and the relative humidity on the days when observations were made in June, July and August

	Max °C	Min °C	Relative humidity %
June	22	11	71
July	18	9	69
August	22	8	73

samples were taken on 9th June 1976 and 23rd June 1976 respectively (Figure 29).

The chemical composition of the herbage samples did not show consistent changes in either direction from the beginning of June to the end of August. There was a tendency for crude protein to increase and for ether extract to decrease between June and August. Crude fibre was at a maximum in July when soluble carbohydrate was at a minimum. Phosphorus decreased during the period from June to August while calcium and magnesium did not vary consistently (Table 62).

8:3:11 Faecal analysis

The chemical composition of the faecal samples fluctuated more widely and erratically than that of the herbage samples. This may be because the samples were not taken from each horse at regular intervals during the day and diurnal fluctuations in faecal composition were detected in the analysis (Table 63).

8:3:12 The weights of the mares

The average weight of each mare did not vary more than 5% between June, July and August 1976 (Table 64).

TABLE 62 The chemical composition of the herbage samples collected in June, July and August 1976, expressed as g/kg dry material

	Crude Protein	Crude Fibre	Ether Extract	Ash	Nitrogen-free Extract	Ca	P	Mg
9 June	112.5	323.0	17.4	96.6	450.5	4.6	3.2	1.6
23 June	128.1	325.2	16.4	119.5	410.8	5.4	3.4	1.8
7 July	115.9	351.2	19.3	116.1	397.5	5.7	3.0	1.9
23 July	134.4	402.2	14.8	97.1	351.5	5.2	2.6	1.8
4 August	137.3	304.5	13.7	118.6	426.0	5.5	2.9	1.9
27 August	146.6	291.4	12.3	86.8	462.8	5.3	2.4	1.9

TABLE 63 The chemical composition of the faeces samples collected in June, July and August 1976, expressed as g/kg dry material

	Crude Protein	Crude Fibre	Ether Extract	Ash	Nitrogen-free Extract	Ca	P	Mg
June (1)	96.68	334.89	53.65	191.82	322.96	2.86	8.50	1.91
June (2)	93.29	184.42	40.11	154.50	527.68	2.57	7.05	1.92
July (1)	102.98	358.65	52.28	157.66	328.66	4.09	7.40	2.69
July (2)	79.33	382.44	27.63	236.47	274.13	3.25	5.72	1.97
August (1)	94.86	373.64	42.64	218.59	270.27	3.15	4.62	1.69
August (2)	130.74	310.94	47.64	181.41	329.27	3.69	5.99	0.97

TABLE 64

The average weight (kg) of the mares in June, July and August 1976

	Emma	Gay	Flatspin	Kirsty
June	-	492	555	708
July	503	489	537	701
August	508	500	531	705

8:4 Discussion

The results indicate how a group of horses behaved during one 24 hr period in each of the months June, July and August 1976.

The horses spent most of the day grazing or resting and while other behaviour patterns such as walking and grooming occurred often they were not maintained for more than a few minutes at a time. There was a definite tendency for the horses to graze or rest at the same time as each other. When one animal either stopped resting and started to graze or stopped grazing and began to rest the other animals usually did the same within 10 min.

8:4:1 The diurnal distribution of behaviour patterns

8:4:1:1 Grazing behaviour

There were two main grazing periods recorded each month; these were from 17.30 hr to 22.30 hr and from 03.45 hr to 07.20 hr and they correspond to the peak grazing times of New Forest ponies, namely late afternoon until early evening and immediately after dawn (Tyler, 1972). Similarly a regularity in the daily routine of horses was also observed by Barmincev (1951).

There was no obvious reason why the horses rested for longer and grazed for a shorter time in July than in June or August. The average temperature and the relative humidity were lower in July than in June and August which might indicate that the animals should be more active. A more likely reason may be found in the fact that the crude fibre of the herbage was greater in July

than in the other two months. Therefore the herbage might have filled the horses' gut faster and slowed down the rate of passage of food through the gut thus giving a sense of repletion after a shorter grazing time. This is known to be true in ruminants (Blaxter et al., 1956; Campling, 1966). This is further emphasised by the fact that with rising fibre content in a ration the digestibility of organic matter is reduced for both horses and cattle but the reduction is greater for horses (Olsson and Ruudvere, 1955).

The horses grouped periods of grazing behaviour into meals and this is similar to the way housed cattle grouped periods of feeding behaviour into meals with inter-meal intervals of 20 min or longer (Metz, 1975). If a different recording technique had been used to observe the horses - continuous recording for instance - then the intra-meal intervals may be found to be either shorter or longer than the 5 min maximum duration found here. In addition with further observations it may be found that there is an optimum length for inter-meal intervals and when an interval reaches this time the likelihood of a horse starting to graze is very high.

8:4:1:2 Resting behaviour

Reports on the times when horses rest vary. In this study proportionally more rest occurred at night than during the daylight. Similarly stalled horses rest only at night (Ruckebusch, 1972) and this may be of evolutionary significance in that darkness provides protection

from predators. However it contrasts with a statement by Hafez, Williams and Wierzbowski (1969) that horses rest mostly during the hottest part of the day.

Most horses lie down at least once a day (Waring, Wierzbowski and Hafez, 1975) since recumbency is necessary for the occurrence of paradoxical sleep (Ruckebusch et al., 1970). Unfortunately it was not possible to check this in the present study since the horses were not observed for continuous periods of 24 hr.

If the results from this study are compared with those recorded in February 1975 (Section 7) then it can be seen that the horses spent less time resting in June and August and more time in July than they had in February. However a greater difference was found in the times when the horses rested. In February 87% of resting behaviour occurred between 20.00 hr and 08.00 hr while in the summer months only 49% occurred between these times. However this is probably biased by the management of the horses. In February the horses were stalled during part of the day and were supplied hay at 08.45 hr and at 16.45 hr. Since supply times are known to immediately precede a large meal (Doreau, 1978) and both supply times were in the 08.00 hr to 20.00 hr period then feeding behaviour is more likely to occur during this time with the result that more resting behaviour will occur during the night.

8:4:2 Grazing behaviour on the lawns and roughs

Horses kept in paddocks characteristically group their excrement

into certain areas of the field and graze the 'clean' areas (Odberg and Francis-Smith, 1976). The mares and juveniles were no exception to this. However the juveniles were even more particular about grazing the lawns in preference to the roughs, than the mares. The juveniles maintained this preference during June, July and August whereas the mares grazed the roughs more in July than in June and by August the mares appeared to graze the paddock randomly.

In August there was only one juvenile (Albert) in the group and because of this the accuracy of the data on Albert (Tables 52 and 53) should be considered critically. Albert spent 89% of the grazing time during daylight hours on lawns in August and this figure is slightly greater than those figures obtained in June and July for all the juveniles. The four mares in August grazed the lawns for an average of 36% of the time. There was little variation between the mares and therefore Albert's value, 89%. was very different from the mares' value. It appears that although Albert was the only juvenile present in August his tendency to graze the lawns rather than the roughs was consistent with that shown by the juveniles in June and July, and was inductively representative of the behaviour of the juveniles if they had all been present in the group in August.

The herbage yield of the paddock declined steadily from the beginning of June to the end of August and it was probably the poor grass on the lawns that made the mares spend an increasing amount of time grazing the roughs. The body weight of the mares

did not vary greatly between the months indicating that by grazing the roughs they were able to maintain their nutritional requirements.

The juveniles may have continued to graze the lawns for one or two reasons. In the first place the mares had larger nutritional requirements, due to their greater body weight and state of pregnancy, than the juveniles. Therefore the juveniles may have been able to meet their nutritional requirements by grazing the lawns in preference to the roughs whereas the mares were unable to do this. Unfortunately, the juveniles were not weighed during the experiment and it is not known whether or not they lost weight by grazing the lawns so persistently. They did however stay in good condition and did not appear to lose weight during the experiment. Secondly, there is more significance attached to the excretions of male horses than females (Feist, 1971) and since the two geldings showed more elaborate behaviour patterns surrounding excretions than the mares, they may also have had a greater aversion to grazing the roughs. Dux the female juvenile had been associated with the geldings from birth, and since horses that have been together in a group for long periods prefer to stay together (Waring et al., 1975) it is likely that Dux, Passion and Albert would graze together because of a bond between them.

Unfortunately, during the experiment the changes in the sward were not as obvious as indicated by Plate 6. The location of the original lawns and roughs was still apparent but it would have been interesting to draw the map of the field each month to see

if the lawns and roughs changed in shape. By August some roughs had become so grazed that they would then have been classed as lawns with herbage less than 5 cm tall.

8:4:3 Social behaviour

The horses observed in this study behaved as one group for grazing and resting behaviour: they all tended to graze together and to rest together. However, the juveniles and the mares could be considered as two subgroups in several ways. The juveniles showed a different reaction to the lawns and roughs, they tended to travel farther during the day than the mares and there were more social interactions between two juveniles or between two mares than between mares and juveniles. There were also differences in the way the animals were spatially segregated. The distance between any juvenile and any mare was usually greater than the distance between either two mares or two juveniles. However these differences were not present when the horses were resting.

The linear dominance hierarchy found within the group is consistent with other small domestic horse groups (Houpt et al., 1978) and with groups of free-ranging horses (Berger, 1977); Welsh, 1973). Amongst the mares there was no correlation either between the mares' age and rank or between her body weight and rank. The two smaller mares (Emma and Gay) were dominant to the two larger ones (Kirsty and Flatspin) and Emma, the youngest mare, was the top ranking horse in the group. In contrast other workers have found that age and weight are the most important factors governing the rank of a horse (Montgomery, 1957; Tyler, 1972). However all the

juveniles were subordinate to all the mares which is in agreement with the finding of Houpt et al. (1978).

Amongst the mares and juveniles there did not seem to be any connection between dominance and leadership and in many cases the more subordinate horses initiated activities and were followed by the rest of the group. In some feral horse groups the stallion is both the dominant animal and the leader of the group (Feist and McCullough, 1976; Ebhardt, 1954). On the other hand, Welsh (1973) reported that although the stallion was usually the dominant animal, the senior and most dominant mare in the group usually initiated movement of the group, and Tyler (1972) observed that the dominant mare in a group was also the leader.

Incidents of allogrooming recorded from pairs of horses in the group were always mutual. Only a few pairs of animals groomed together: of a total of 73 incidents, 49 were between Gay and Flatspin and 15 were between Passion and Albert. There was only one instance of a mare (Emma) mutually grooming a juvenile (Albert). In 72 of the incidents the dominant animal initiated mutual grooming and in 63 cases the subordinate horse ended it. In contrast to this Tyler (1972) observed that the subordinate pony was most likely to initiate mutual grooming and least likely to end it. Feist (1971) observed all members of a group of feral horses grooming one another, except foals with the stallion, while the New Forest pony mares restricted their mutal grooming to certain partners (Tyler, 1972). It has been thought that allo-grooming in primates has a social function; it maintains cohesion

in a group by reducing fear in the subordinate animals and allowing the whole group to maintain social contact (Sparks, 1967). It seems unlikely that mutual grooming has this function in the horses observed here since only two regular grooming pairs were observed and in each pair the two horses involved were closely ranked in the dominance hierarchy. The primary function of mutual grooming in these horses is thought to be to groom areas of the skin that a horse cannot reach by itself.

The main difference between farm-kept horses and free-ranging horses is the area over which the animals are allowed to travel. The group observed here was enclosed in a paddock of 1.273 ha with trees and bushes along two adjacent sides of the paddock. Groups of New Forest ponies had home ranges which varied between 82 and 1020 ha; the size of home range was determined by the ponies' requirements which were a grazing area, water, shelter, and shade. When these were close together the home range was small (Tyler, 1972). Therefore provided that the grazing in paddocks is adequate for the number of horses pastured on it, and that water, shelter and shade are present, the size of paddock should not have an important effect on the behaviour of the horses.

Some of these results have been presented previously (see appended paper; Francis-Smith, 1977).

9 THE DESIGN AND USE OF AN ELECTRONIC DEVICE TO RECORD THE GRAZING BEHAVIOUR OF HORSES

9 The design and use of an electronic device to record the grazing behaviour of horses

9:1 Introduction

Visual observation is still the most common method used to record the grazing behaviour of horses (Archer, 1977; Rogalski, 1975a; Schoen et al., 1976). This method is time consuming and it involves work at anti-social hours. In addition, unless a large workforce is available, continuous recordings for consecutive periods of 24 hr are impossible. Reliable and economical grazing recorders are available for use with cattle and sheep (Allden, 1962; Ruckebusch and Bueno, 1973) but there is nothing similar for horses. If suitable equipment could be designed to record the grazing behaviour of horses over periods of 24 hr then it would provide tremendous scope for studies on horse behaviour, management and nutrition.

9:1:1 Existing methods used to record grazing behaviour

Initially previous methods used to record grazing behaviour of different ungulate species were considered. In the first place telemetry and time-lapse photography were eliminated since they are unsuitable in field conditions. Secondly vibracorders (Allden, 1962) were a possibility. However these recorders use the jerky head movements of grazing cattle and sheep that occur when the grazing animal 'tears' the grass for each mouthful. Since horses 'bite' the grass their head movements are less pronounced

and it was felt that these movements would not be sufficient to leave a trace on a vibracorder.

The first attempt to build a grazing recorder in this study was based on a design by Canaway et al., (1955). This was a battery driven chart recorder which was fitted into a harness and strapped to the back of a horse. However as it was bulky and impractical it was discontinued in the early stages. Secondly a system that had been designed to record the grazing behaviour of cattle (O'Shea, 1969) was adapted for use with horses. This design used a mercury switch attached to the horse's headcollar and connected to a battery driven elapsed time recorder, which was fitted into a cylindrical container and fixed under the metal hoop of an anti-cast roller. Unfortunately this method was also impractical. During overnight recordings either the roller slipped, the recorder fell out of the hoop or the lead from the switch to the recorder broke. It was by this stage that some essential requirements of a grazing recorder for horses had become apparent. The recorder should be compact, lightweight, self-contained and extremely robust. It was decided that a completely new design was essential.

9:1:2 A new approach

Two points were of particular importance when the grazing recorder was designed. In the first place, any extraneous switches and leads would be easily damaged when the horse

either groomed itself or rolled. Secondly, grazing activity could be measured most easily from the movements in the horse's head: either jaw movements, jaw muscle, activity or vertical changes in head position. Therefore it followed that the recorder should be sufficiently compact and lightweight to be carried on the horse's head. In addition to this the switch picking up grazing activity would have to be incorporated into the recorder to prevent damage. It was therefore decided to design an electronic grazing recorder which incorporated a mercury tilt switch.

9:2 The electronic recording system

The recording system consisted of portable recorders and a replay system. A recorder and a mercury tilt switch were contained in a leather pouch attached to a horse's headcollar. Data on grazing behaviour was collected over periods of 24 hr using the recorders, which were changed daily, and the data was retrieved using the replay system.

9:2:1 The recorder box

The recorders were self-contained sampled data recorders which used integrated circuits powered by nickel-cadmium rechargeable cells (Appendix 14:7). Each recorder was fixed into a box, 170 x 67 x 20 mm, which was made from sheet aluminium 1 mm thick. A mercury tilt switch and a 6 v battery were also contained in the box.

The mercury tilt switch sensed the attitude of the recorder and provided a signal which was sampled and recorded in the memory at pre-determined intervals. The samples remained stored in the memory until the replay box was used to sequentially recall them for analysis. As the memory could store a maximum of 1,024 samples a sampling interval of 2 min was used. In this way a recorder could sample for a maximum of 34 hr. When a sample count of 1,024 was reached further recording was inhibited and the samples were held in the memory for replay.

The recorder had two modes of operation, these were 'sample' and 'hold', and a sample/hold switch was inset into the side of the box. Data was collected using the 'sample' mode and sampling could be stopped at any time by switching to the 'hold' mode. In the 'hold' mode the internal clock was inhibited and the data was available for replay (Appendix 14:7:1).

9:2:2 The replay box

The replay box was connected to the recorder box to retrieve the recorded data. With the sample/hold switch in the 'hold' position, the replay box provided an external count input to the sample counter which could be incremented at will to display the switch signal as recorded for any sample.

The replay box also had a sampling indicator with which the accuracy of the sampling time interval of the recorder could be checked.

In addition to the functions described above, the replay box also contained a mains power unit and a charger circuit for the 6 v nickel cadmium batteries (Appendix 14:7:2).

9:2:3 The mercury tilt switch

Each switch was made from two hollow 'T-shaped' pieces of plastic connected by flexible plastic tubing 3 mm in diameter and with a brass electrode inserted into one arm of each 'T-piece'. The switches were assembled and filled with glycerine and mercury. The amount of mercury in each switch was adjusted until the mercury made contact with both electrodes when the switch was at an angle of 32 degrees or less to the vertical, and the joins were then sealed with silicone rubber (Figure 30).

The switches were only 4 mm thick and were taped into the aluminium boxes lying against the recorder and with the straight sides of the switch lying parallel to the long sides of the box (Figure 31).

9:3 Operation of the grazing recorder

Before use the recorders were switched to the 'sample'

mode for 10 min to warm up. The mode was then switched to 'hold', the recorder connected to the replay box and the sample counter reset to zero. At a pre-determined time the mode was switched back to 'sample', the recorder box was closed and put into a felt pouch and a plastic bag before being slipped into the leather pouch on the headcollar. The opening in the leather pouch was laced up and the headcollar was immediately taken to the field and fitted on a horse (Plate 7). If recordings were being made on consecutive days the recorder was exchanged with the one already carried on the horse.

The recorder containing data was removed from the pouch and the sample/hold switch was moved to the 'hold' position. Data could then be stored in the recorder until the operator was available to recall it with the replay box. The data, when retrieved, indicated the status of the mercury switch at 2 min intervals during the recording period.

The head collars had adjustable straps and a leather pouch attached to each cheekpiece. These pouches were fastened along the lower short edge by lacing them up with a shoe lace which helped to prevent rainwater from entering. The adjustable straps allowed the headcollar to be fitted comfortably on any horse, so that the leather pouch lay against the horse's cheek and did not swing out when the horse moved its head. Furthermore a

small weight was kept in one pouch of each headcollar to balance the weight of the recorder in the other pouch. Each recorder containing a battery weighed 280 g and a headcollar complete with a recorder and a balancing weight weighed 830 g. The horses did not show any reaction to wearing the recorder and there was no evidence that the recorders affected the behaviour of the horses.

9:4 The reliability of the mercury switch

The use of this recorder was based on the assumption that when the mercury switch was closed the horse was grazing. That is, when the horse's head was at an angle of 32 degrees or less to the vertical the horse was grazing (Plate 8, Figure 30).

To ascertain the correlation between the status of the mercury switch and the horse's behaviour, a switch monitor was used in conjunction with visual observations (Appendix 14:7:3). The switch monitor was connected to the recorder and attached to the outside of the leather pouch during recordings. When the mercury switch was closed it illuminated a small red light on the switch monitor. This could be observed during both daylight and darkness and gave an accurate indication of the status of the mercury switch.

Observations made in this way indicated that when the mercury tilt switch was designed to switch on at an angle

of 32 degrees or less to the vertical it was on all the time that the horse was grazing and rarely if the horse was not grazing, which was when the horse explored the ground and its head was in the same position as when grazing. A delay of up to 5 sec occurred on the change in status of the switch when the horse raised and lowered its head. Furthermore the switch monitor indicated that when horses were lying down the switch remained in the off position. In addition to observations in the field the switch monitor, when used on a horse under anaesthesia, showed that the mercury switch was off while the horse was lying on its side on a level floor.

9:5 Problems associated with the grazing recorder

A total of three recorders and one replay box were built but only four of the special 6 v batteries were available. In addition two headcollars were specially made with adjustable straps and leather pouches, 105 x 25 cm, attached to each cheek piece.

The plastic cell packs, each of which contained four 1.5 v cells, caused more problems than any other aspect of the design. After a few weeks these packs started to split and ceased to hold the cells in position, causing either a loss of power in the circuit or the battery to discharge. Eventually only two battery packs were in a usable condition and the cells had to be taped into position. This is an aspect of the design which

could be improved in a future model.

Initially problems also arose in connection with the leather pouch which became twisted round the headcollar strap during the night. To prevent this the pouch was riveted to the headcollar down the centre of one side of the pouch and also sewn to the headcollar at two of its corners. In this way the pouch and the recorder box remained flat against the horse's cheek during 24 hr recordings.

The mercury switches had a useful life of three weeks before the conductivity between the brass electrode and the mercury was impaired. This was probably caused by some interaction between any of the materials (plastic, mercury, glycerine and brass) incorporated in the switch. In the present study this was not a serious problem once it had been recognised, since the switches were easily assembled and all parts for the switch were readily available. However if this equipment was to be used on a larger scale, the switches could be custom made of the correct materials to prevent this problem occurring.

The recorder operated reliably at normal temperatures down to freezing point and the accuracy of the sampling interval was checked for each recorder using the facility on the replay box (Appendix 14:7:2). The error in the

sampling interval of each of the three recorders was a loss of 1 min, 5 min and 8 min in 24 hours. This is equivalent to a maximum error of 0.5% which was felt to be negligible. Some improvements to the design of the recorder have been outlined which include an improved method of controlling the sampling interval that would use a wrist watch type of integrated circuit and quartz crystal which can be set very accurately to any size of sampling interval. This type of circuit would work reliably at all environmental temperatures normally encountered, whereas the clock circuit used in the present design would be affected by temperatures below freezing point and would therefore upset the sampling interval.

Since this equipment was designed to make Grazing Recordings Under Normal Conditions for Horses it will hereafter be referred to as a Grunch.

9:6 Two pilot studies to record the grazing behaviour of horses using the Grunch

9:6:1 The first pilot study

9:6:1:1 Introduction

This was the first attempt to use the Grunch after it had been built and the reliability of the mercury switches had been established.

9:6:1:2 Materials and methods

The grazing behaviour of two horses, Adam and Oakleigh, was recorded during one four hour period, from 10.00 hr to 14.00 hr, on each of five consecutive days and during one 24 hr period on the sixth day. Recordings were made using the Grunch together with visual observations during

the four hour observation periods.

Both horses had been pastured on Field 3 for eight weeks before recordings began and they were both accustomed to wearing the grazing recorder.

9:6:1:3 Results

The grazing times recorded during the four hour observation periods are shown in Table 65. During these recordings the maximum error made by the Grunch was not more than 5% of four hours and the mean error was 1.62%. This is equivalent to an error of 23 min in 24 hr.

The grazing behaviour of Adam and Oakleigh recorded during one period of 24 hr is shown in Figure 32. There were three major grazing periods, occurring from 05.00 hr to 08.20 hr, from 09.10 hr to 22.30 hr and from 24.00 hr until 03.10 hr. The two horses grazed at similar times to each other although Adam grazed for 18 hr 24 min which was longer than Oakleigh, which grazed for 15 hr 50 min. However Adam was the larger of the two horses weighing 760 kg compared with Oakleigh which weighed 460 kg. The longest continuous period of grazing behaviour was 178 min in duration and was recorded from Adam between 15.48 hr and 18.46 hr. Breaks in grazing behaviour varied between 2 min and 96 min in duration with the longest breaks occurring between the three major grazing periods.

TABLE 65 The grazing times of two horses recorded using a Grunch and visual observations concurrently, during 4 hrs on each of five consecutive days

Date	Horse	Grazing Time		Difference expressed
		Grunch	Visual observations	as a percentage of 4 hr
17:8:78	Adam	2 hr 42 min	2 hr 51 min	-3.75%
	Oakleigh	3 hr 18 min	3 hr 15 min	1.25%
18:8:78	Adam	3 hr 30 min	3 hr 31 min	-0.41%
	Oakleigh	2 hr 38 min	2 hr 28 min	4.17%
19:8:78	Adam	3 hr 34 min	3 hr 26 min	3.33%
	Oakleigh	3 hr 26 min	3 hr 15 min	4.58%
20:8:78	Adam	2 hr 28 min	2 hr 25 min	1.24%
	Oakleigh	3 hr 0 min	2 hr 53 min	2.92%
21:8:78	Adam	3 hr 14 min	3 hr 10 min	1.67%
	Oakleigh	2 hr 40 min	2 hr 37 min	1.25%

9:6:1:4 Discussion

The Grunch tended to overestimate the time that the horses spent grazing when compared with visual observations. Possibly this was because the Grunch 'missed' the many short interruptions that the horses made in grazing behaviour, to walk, groom or stand still while these were all included in non-grazing time recorded using visual observations.

The grazing behaviour recorded during the one period of 24 hr had a similar diurnal distribution to the grazing behaviour recorded from five horses in August 1976 (Section 8). With few exceptions the major grazing periods occurred at similar times in the two different years (Figures 25 and 32). In 1976 all the horses had two rests, one at 14.00 hr and one at 16.00 hr, but these rests did not occurr in 1978. Instead Oakleigh had two breaks in grazing between 11.30 hr and 13.20 hr while Adam grazed almost continuously from 9.10 hr to 22.40 hr.

It seemed from the results collected in this experiment and also from the reliability of the mercury switch that the Grunch is an accurate and time-saving means of collecting data on the grazing behaviour of horses.

9:6:2 The second pilot study

9:6:2:1 Introduction

Following from the first pilot study it had been hoped to run an experiment to record the grazing behaviour of a group of five horses over a prolonged period. However it was at this time that the first problems arose with the batteries and switches (Section 9:5). Once these problems had been identified and solved the horses that had been used as subjects were no longer at grass. Two other horses - Kirsty and Flatspin - were available from the middle of November. However by this time only two batteries were in a usable condition. Therefore the behaviour of only one horse could be monitored at a time.

9:6:2:2 Materials and methods

Kirsty and Flatspin were pastured on Field 4 from the middle of November and the grazing behaviour of Kirsty was monitored, using the Grunch, from 14.00 hr on 5:12:78 until 14.00 hr on 13:12:78. One 24 hr period, from 8:12:78 to 9:12:78, was excluded from the results since Kirsty was taken out of the field during the afternoon of the 8th December. Recordings were stopped on 13:12:78 because the temperature fell below freezing and hay was fed to the horses. Before these observations Kirsty wore a headcollar and recorder box to accustom her to the feel of it.

Since the grass was very poor during the time that Kirsty and Flatspin were pastured on Field 4 they received 2 kg oats twice a day. One feed was given between 08.00 hr and 09.00 hr and the other between 16.00 hr and 17.00 hr. Each feed was eaten in less than 20 min and this time is included in the grazing time reported in the results.

9:6:2:3 Results

Kirsty grazed for a mean duration of 15 hr 40 min per 24 hr during the seven 24 hr periods of recording (Table 66).

The diurnal distribution of Kirsty's grazing behaviour is shown in Figure 33. There were between five and seven major grazing periods a day which included frequent short intervals in grazing behaviour. The longest intervals varying in duration from 1 hr 20 min to 3 hr 40 min occurred between 01.00 hr and 07.00 hr each day. A shorter interval in grazing behaviour also occurred between 10.00 hr and 12.30 hr. The remaining major intervals in grazing behaviour occurred at less regular times and no pattern was apparent between the different days.

The spot observations showed a close agreement with the Grunch recordings (Table 67). Six observations did not agree with the Grunch recordings but it is thought that

TABLE 66 The duration of grazing behaviour recorded from Kirsty during seven 24 hr periods

DATE				DURATION OF GRAZING BEHAVIOUR
1.	5:12:78	-	6:12:78	16 hr 20 min
2.	6:12:78	-	7:12:78	14 hr 34 min
3.	7:12:78	-	8:12:78	16 hr 50 min
4.	8:12:78	-	9:12:78	Recordings were not made
5.	9:12:78	-	10:12:78	14 hr 38 min
6.	10:12:78	-	11:12:78	15 hr 16 min
7.	11:12:78	-	12:12:78	15 hr 30 min
8.	12:12:78	-	13:12:78	16 hr 38 min

TABLE 67 The behaviour patterns recorded from Kirsty on intermittent observations on the dates and times shown

Date	Time	Behaviour pattern
5:12:78	14:30	Grazing
	16:00	Standing still
6:12:78	11.00	Resting standing
	11.30	Grazing
	11.40	Grazing
	14.15	Grazing
	15.00	Grazing
	15.15	Grazing
	15.45	Grazing
7:12:78	11.05	Resting standing
	11.45	Resting standing
	12.45	Grazing
	13.00	Grazing
	13.00	Walking
	13.00	Grazing
	14.15	Grazing
8:12:78	09.30	Grazing
	09.50	Grazing
	12.15	Resting standing
	12.25	Resting standing
	12.45	Grazing
9:12:78	14.15	Grazing
	14.20	Grazing
10:12:78	11.40	Resting standing
	12.00	Grazing
	14.15	Resting standing
	14.55	Grazing
	15.00	Grazing
	15.00	Grazing
11:12:78	10.20	Grazing
	11.00	Resting lying
	11.30	Grazing
	11.40	Grazing
	12.30	Grazing
	13.45	Grazing
12:12:78	10.50	Grazing
	11.00	Resting standing
	11.15	* Grazing
	11.20	Resting standing

TABLE 67 (cont.)

Date	Time	Behaviour pattern
	11.35	Grazing
	14.10	Grazing
	14.20	Grazing
	14.35	Grazing
	14.40	Grazing
	14.50	*Standing
	14.55	Grazing
	16.00	*Standing
	16.10	Standing
13:12:78	09.45	Grazing
	10.30	Resting standing
	11.05	Grazing
	11.10	*Standing
	11.15	Grazing
	11.40	Grazing
	11.50	*Walking
	12.00	Grazing
	12.05	Urinating
	12.05	Grazing
	12.30	Grazing

* This indicates behaviour patterns which were recorded with visual observations but which disagree with the Grunch recordings (Figure 33).

five of these were behaviour patterns that lasted for less than 2 min and therefore occurred within sampling intervals. The sixth difference - recorded at 11.30 hr on 6:12:78 - showed that Kirsty was grazing but grazing behaviour was not recorded by the Grunch at this time. However only 8 min later grazing behaviour was recorded by the Grunch and this was probably an error in co-ordination between the time of intermittent observations and the Grunch sampling intervals.

9:6:2:4 Discussion

This experiment shows the first results on the grazing behaviour of one horse over consecutive periods of 24 hr recorded using a Grunch. The close agreement between the Grunch recordings and the intermittent observations supports the belief that the Grunch is a reliable method to record the grazing behaviour of horses.

The mean grazing duration of Kirsty - 15 hr 40 min - was less than that recorded during the summer months in 1976 (Section 8). However in December Kirsty was receiving 4 kg oats per day and this would reduce her herbage intake and therefore grazing time. Periods of grazing behaviour appeared to be more fragmented than those recorded in 1976 and this may also have been an effect of the supplementary food which decreased the intensity of the grazing periods. The diurnal distribution of grazing behaviour is less consistent between days

than had been expected.

9:7 General discussion on the use of the Grunch

9:7:1 The present model

The Grunch was built with the aim of developing a reliable and labour-saving piece of equipment to record the grazing behaviour of horses. In its present design the Grunch was easy to use and laboratory staff could be quickly trained to use it. The most time consuming operation was the retrieval of data which only took 20 min to extract the data collected by one recorder during a 24 hr period.

The recorder was used successfully at environmental temperatures down to freezing point and also during periods of heavy rain. It suffered no physical damage as a result of the horses' grooming activities and it remained securely in position during 24 hr recording periods. The greatest problem encountered with the Grunch was the inadequacy of the battery packs and this limited the amount of recordings made in the present study. This was a design fault and could be adjusted in a future model (Section 9:7:2; Appendix 14.7:4). It had been hoped to use two recorders on one horse to verify the accuracy of the recordings but the lack of batteries made this impossible.

The Grunch was designed with four basic points as

essential features - it had to be compact, lightweight, self-contained and extremely robust - and the results show that the Grunch is a suitable means of recording the grazing behaviour of horses automatically. It is hoped that this work is just the beginning of the development of electronic equipment based on the principles used here.

9:7:2 Possible improvements to the Grunch

The clock circuit in the present design consumed a current of approximately 10 mA and hence relatively large Nickel-Cadmium cells were required. In addition, the sampling interval was difficult to set precisely with this type of clock circuit and it may fluctuate at the extremes of the normal environmental temperature range. Since the Grunch was designed, an improved version of the clock integrated circuit has become available which draws a considerably smaller current - 0.5 mA - and would thus reduce the battery size and weight required to 1/6 of its present size. A better solution, however, would be to use one of the new integrated circuits and quartz crystal now used in wrist-watches. This would give a very low power, frequency stable clock source. If this latter option was used the size of the recorder box could be reduced to one third of its present size. In either case the battery could be fixed into the recorder and charged while in this position.

A further improvement could be made by increasing the number of samples held in the memory. Integrated circuits are currently available with memory capacity 16 times greater than that used in the present design. This could be used to either increase the duration of recording, frequency of sampling or record several channels of data simultaneously. Improvements could also be made to the replay box. It could either be adapted to connect to a printing device to provide a hard copy of the data, or, better still, a direct connection could be made to a suitable computer which could then process the results as they are retrieved.

The cost of a Grunch system, if built on a commercial scale, is estimated to be approximately £100 for each recorder box of an improved design and £200 for a replay box of the present design.

10 GENERAL DISCUSSION - PRESENT WORK AND TOPICS FOR FUTURE RESEARCH

10 General discussion - present work and topics for future research

It was apparent from the literature on domestic horse behaviour that some aspects of behaviour had not been studied. The main topics that were neglected were the behaviour of foals between birth and weaning, the diurnal duration and distribution of behaviour patterns and some aspects of grazing behaviour.

Since it is well known that early experience affects subsequent behavioural development in other animals (Denenburg, 1969) then this is also likely to be true for foals. The function of horses in Britain demands that they have a close relationship with humans for both work and leisure activities and it may therefore be important to know how the management practices of foals affects their later behaviour. For this reason, it was decided to study foals during the months between birth and weaning.

In some ways the mares and foals showed behaviour patterns pertinent to their feral counterparts. The mares were particularly attentive to their foals and aggressive towards all other moving objects on the foals' first day of life despite being confined in the stable and in these circumstances the mares may feel uncomfortable. It may therefore be better for their general health if mares and their foals are pastured with other horses as soon as

possible after parturition to allow this behaviour pattern to take its natural course. When the mares and foals were pastured the foals were responsible for maintaining contact with their dams whereas surprisingly the mares paid little attention to their foals even when they were out of contact. The reason for this is unknown but it is suggested that the foals were never out of sight of their dams and therefore the dams did not need to look for them.

After four weeks of age the foals were often grazing and resting together and only approached their dams to nurse. They showed little aggression towards one another and a facial threat expression was not observed until they were between six and eight weeks old. Even then threats rarely occurred and when they did the contexts were non-specific. As stated previously immature horses are less aggressive than adults (Houpt et al., 1978) and it could be concluded that until horses are sexually mature aggression has no function. Once animals are mature however aggression is necessary for stallions to keep other stallions away from their mares and for mares to protect their foals.

Since the ability to graze has to be learned (Glendinning, 1977) the range of motor skills and social behaviour patterns that foals learn from adult horses could include almost everything they do. In the wild situation a

foal is never isolated from its herd and the opportunity to learn from adults is always present. It has even been suggested that the submissive gesture of 'grinning' while standing still is a means whereby a foal can express submission without being driven away from the herd (Schafer, 1975). Presumably foals do learn a great deal from one another and from other adults and a comparison between foals reared in isolation of other mare-foal pairs and those reared in groups may reveal interesting differences in their tractability during training and in the company of other horses. Unfortunately the present study could not be extended to the time when these foals were trained but this is an important area for future research.

Another interesting recording made during the work on the foals was that of coprophagia. This behaviour pattern is a normal part of the foal's development which commonly occurs during the first month of life (Taylor, 1954; Tyler, 1972) and it provides foals with gut bacteria necessary for caecal digestion (Baintner et al., 1971). Interestingly one foal, at 20 weeks of age, after having received a course of antibiotics ate his dam's faeces outwith the normal period for coprophagia and it was postulated that the antibiotics had destroyed his gut flora and he restored the balance by reverting to a behaviour pattern contingent with an earlier time of life.

In general the work on the foals helps to fill a gap in present literature and also poses some interesting questions for future research.

A knowledge of the grazing behaviour and the daily activity of horses becomes increasingly important as the horse population of Britain increases. This is of particular interest in the home counties where farms are being split up and sold for horse pasture at prices that are much higher than those fetched for farmland. This is causing concern about the stability of the green belt because once land has been used as horse pasture and has the derelict appearance of a horse grazed paddock then there is an increased likelihood that permission to build on this land will be given (Grice, 1979). Therefore an improved knowledge of horse behaviour and management would not only maximise the output from the land but would also help to maintain the beauty of the countryside.

Up to now visual observation has been the only method used to record grazing behaviour and the obvious drawbacks of this technique encouraged efforts to build automatic recording equipment. An electronic instrument was designed and used successfully and is referred to as a Grunch. The scope of the Grunch is such that the duration and distribution of daily grazing behaviour of any number of horses could be recorded during successive 24 hr

periods with minimal labour. If the suggested improvements to the present design were made then a recorder the size of a wristwatch could have the capacity to either record on several channels at once, to record continuously during several successive 24 hr periods or to sample at intervals of only a few seconds. This data could be collected for a variety of experimental designs. The short sampling intervals could be used to investigate the occurrence of meals and the distinction between inter- and intra-meal intervals. The capacity to record continuously during successive periods of 24 hr would prevent interruptions in recording at times when technical staff are absent and could also be used to monitor free-ranging animals when it is best to disturb them as little as possible. If the facility to record on more than one channel was used then other parameters in addition to grazing behaviour could be recorded. However this would require extra switches to pick up the relevant stimuli and it is unlikely that they would all be of the right design to be incorporated into the Grunch. Extraneous switches would therefore be necessary and the Grunch would cease to be self-contained. However if other data were required, such as respiratory rate and leg movement, then switches could be specifically designed and incorporated into separate recorders to be attached to the relevant part of the horse. It is felt that the scope of future research using the Grunch is large and that it should provide a means by which the effect of the many influences on grazing behaviour can be monitored.

It is known that pasture grazed solely by horses soon deteriorates into overgrazed areas, rough areas and patches of bare soil due to the eliminative behaviour patterns of horses (Archer, 1972b). For this reason correct paddock management is essential to maintain balanced pastures, in particular where agricultural land is being split up into small units to be used as horse pasture. During the work reported in Section 5, although not quantitatively recorded, it was noticed that the mares excreted indiscriminately over the pasture contrary to the usual pattern whereby horses in fields group their excrement into specific areas. In addition to the mares and foals the field was grazed intermittently by sheep and cattle and, instead of the appearance of roughs and lawns, after six months the field still had an evenly grazed appearance. The three different species had grazed over each other's defaecations (Kiley-Worthington, 1977) but it was also thought that the presence of cattle and sheep had caused the mares to excrete at random instead of grouping excrement as normal. The knowledge that mixed species grazing is best for the pasture is not new but the reasons why horses might change their eliminative behaviour patterns in the presence of other species may provide some clues as to how horses could be encouraged to stop grouping excrement in the absence of other species.

It was also observed that the feeding of supplementary hay to horses at grass changed their eliminative behaviour patterns. The horses soiled the hay and the area of lawns around it and this affected the subsequent use of the field since the soiled area developed into roughs and paths reducing the grazed area of the field. It was suggested that the use of a moveable hayrack would spread fouling and damage over the pasture and it would therefore be interesting to investigate how horses' eliminative behaviour patterns are affected by the provision of hay from a hayrack. In addition horses could be observed after the supply of hay ceased in the spring to see how long it takes for them to revert to their normal eliminative patterns.

The horses studied during the months of June, July and August were very particular about grazing the lawns and avoiding the roughs in June when grass was abundant. However as the quantity of available herbage decreased the mares spent more time grazing the roughs and by August there were no areas of abundant herbage in Field 1 (Plate 6). In some cases horses will starve rather than graze roughs (Archer, 1972b) but this was not the case observed here and there is no obvious explanation for the difference.

Some questions arising from this study:

1. What behavioural differences are there between foals

reared in peer groups and foals reared in isolation of other foals?

2. What effect, if any, does the social grouping of foals have on their tractability and relationships with man in adult life?

3. How important is the occurrence of coprophagia for the healthy growth of foals? Do adult horses suffer when, having received a course of antibiotics, they do not have access to the faeces of other adult horses?

4. Consequent to the design of the Grunch questions concerning the grazing behaviour of horses could be studied on a formal experimental basis.

5. Does the presence of cattle and sheep affect the eliminative behaviour patterns of horses? If so what stimuli cause this change and could they be reproduced in the absence of other species?

6. In view of the fact that feeding supplementary hay on the ground to horses at grass changes their eliminative behaviour patterns, would feeding hay from a hay rack have the same effect?

7. Under what conditions will horses graze roughs that they have previously rejected?